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TESTER FOR IR REMOTE CONTROLS

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To Choose The Best In Sound Quality, Be Guided By The Critics

"It was clear and detailed with a crisp and attractively positive presentation. Dynamic range was wide and the player produced vivid stereo with clearly localised images."

JIMMY HUGHES, HI FI ANSWERS MAGAZINE (U.K.) ON THE PD91 REFERENCE SERIES C.D. PLAYER.

"I am forced to note that the sheer goodness of the Pioneer revealed starkly the inconsistent engineering standards at the BBC and other broadcast organisations."

ALVIN GOLD, WHAT HI FI MAGAZINE (U.K.) ON THE F91 REFERENCE SERIES AM/FM TUNER.

"The fidelity, lack of distortion and even the low frequency performance belied the size of the speakers, their cost and their miniscule proportions. The quality of sound was right on par with my reference speakers and I was more than impressed."

LOUIS CHALLIS, ETI (ELECTRONICS TODAY INTERNATIONAL) ON S55T LOUDSPEAKERS.

"I used it to fill a restaurant with sound for a lively office party and accepted accolades on the sound quality all night."

PAT HAYES, ETI (ELECTRONICS TODAY INTERNATIONAL) MAGAZINE OF THE Z770 "MIDI" SIZE HI FI SYSTEM.

"Pioneer's Z990 should be on the short list of anyone looking for a midi system."

CHRIS GREEN, AUSTRALIAN HI FI MAGAZINE ON THE Z990 MIDI SIZE HI FI SYSTEM.

"I see it appealing both to the audiophile wanting a good "purist" machine for sound quality reasons, as well as to the more general user."

JIMMY HUGHES, HI FI ANSWERS MAGAZINE (U.K.) ON THE PD9300 (PD71 IN AUSTRALIA) REFERENCE SERIES C.D. PLAYER.

"This player is a high quality example of the genre. Build and finish are first rate, and the lab performance was superb. Impressive in many ways, it can be recommended with confidence."

MARTIN COLLOMS, WHAT HI FI MAGAZINE (U.K.) ON THE PD6300 C.D. PLAYER.

"Given that it's a good idea having two trays, Pioneer has achieved this enhancement very elegantly and with surprisingly little additional hardware."

JIM ROWE, ELECTRONICS AUSTRALIA MAGAZINE ON THE AWARD-WINNING PDZ72T TWIN TRAY C.D. PLAYER.

HIGH COMMENDATION - DIGITAL AUDIO CATEGORY

C.E.S.A. (AUSTRALIA) AWARD TO THE PDZ72T TWIN TRAY C.D. PLAYER.

"Replay of PAL encoded discs gave superb results. It was virtually impossible to tell it from a normal broadcast picture and was miles better than standard VHS tape."

RICH MAYBURY, WHAT HI FI MAGAZINE ON THE CLD1400/CLD1450 COMBINATION C.D./C.D. VIDEO PLAYER.

"Many people will be surprised that it is a cassette based machine at all, so nearly is it in danger of transcending the natural limitations, and so authoritative is its style of delivery."

HI FI CHOICE MAGAZINE (U.K.) ON THE CT91A CASSETTE DECK.

"The CT656 is a distinguished entrant in the market for budget three head designs. It can be confidently recommended."

HI FI CHOICE MAGAZINE (U.K.) ON THE CT656 CASSETTE DECK.

"Pioneer have just launched a player which sets a standard by which others will be judged."

GRAHAM S. MAYOR, WHICH COMPACT DISC? MAGAZINE (U.K.) ON THE PD91 REFERENCE SERIES C.D. PLAYER.

"Pioneer have done well to put together such a package for this price and the only real problem is to find good enough programming to exercise its virtues."

CHRIS BRYANT, HI FI CHOICE MAGAZINE (U.K.) ON THE F91 REFERENCE SERIES AM/FM DIGITAL TUNER.

"This tuner was free of digital nasties and benefitted from a pleasantly quiet background."

PAUL MILLER, WHAT HI FI MAGAZINE (U.K.) ON THE F225L AM/FM DIGITAL TUNER.

"The Pioneer's impressive specification and build were confirmed by the listening tests."

WHAT HI FI MAGAZINE (U.K.) ON THE CT335 CASSETTE DECK.

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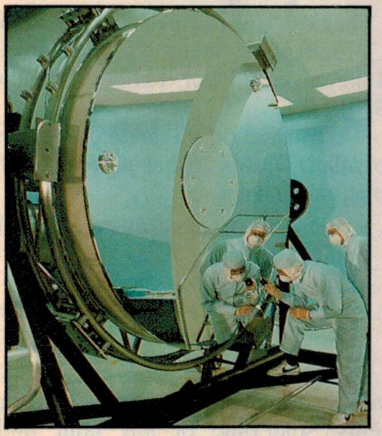
September 1990

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE – ESTABLISHED IN 1922

Inside the Hubble Space Telescope



Despite mirror troubles, NASA's new Hubble Space Telescope is still a very impressive achievement. Kathryn Doolan explains how it went together, and the results to date. (See page 10)

eti

This month's ETI is in the centre of the book, starting opposite page 74. Highlights include Louis Challis's review of Philips' new 'Bitstream' CD player; Roger Harrison's description of a beam antenna for 52MHz; and feature articles on the latest printer technology.

On the cover

Somehow this shot of the launch of NASA's Space Shuttle, carrying the 11.6 tonne Hubble Space Telescope, seems to capture the drama of the project – see page 10. (Picture courtesy NASA).

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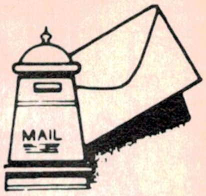
LETTERS TO THE EDITOR



Women in electronics

I read with interest your excellent articles on 'Opportunities for Women in Electronics. The profiles were well written and I will certainly be drawing the attention of my students to them.

I would also like to encourage you in your intention of investigating careers for girls at the trade and technician level, and in your speculations on how participation of girls at the school level can be increased.

As a trained science teacher I have now been teaching Electronics in the HSC Physics course at NSW for nearly 10 years. My school is a non-selective coeducational State high school, where approximately one third of years 11 and 12 students do Physics. In years 9 and 10, the students may also take Electronics as an elective subject (it is taught by the Industrial Arts staff). We have found that less than 10% of these students in years 9 and 10 have been girls.

My own experience with the girls in my classes (20 to 30% of our Physics students are girls) is that:

a) In year 12 girls initially find current electricity ideas and electronics more difficult than the boys do.
b) In year 12 the girls very much enjoy connecting up simple electronic circuits designed to illustrate theory.
c) In Junior Science classes (years 7 to 10) there is no difference between girls and boys in their enjoyment of experiments and understanding of electricity.

I think that we have to try to make electronics much more appealing for girls *at primary and year 7 level* if we wish them to consider it seriously as a career. Perhaps Dick Smith and Jaycar could be encouraged to make special soldering irons for girls, or electronic kits for dolls' houses, or kinetic art kits, or digital logic puzzles with a family flavour. I have found that the favourite Funway kits for girls are the 'Music Maker' and the Dog and Cat Communicator.'

Also, there is at present, hardly any publicity material distributed to high school science teachers re technician and trade level careers in electronics for our students. And after all, we are the ones who teach girls how to connect up circuits.

Thank you again for your article,
Dorothy Roberts,
Chatswood High School,
Chatswood, NSW

DPM project - 1

Thank you for publishing the brilliant 3.5 digit panel meter design from Jeff Monegal and Peter Phillips (*EA* June 1990).

We decided on the meter, as opposed to other DMMs, for a number of reasons, including:

1. Our students can construct the kits with ease.
2. The meters work!
3. Our budget wasn't beaten to death by our purchase.

ITeC electronics students start out with a little or no knowledge of components, soldering, or any fault finding skills. The kit has built confidence and self-worth in these long-term unemployed people, also the students can see their work being of use for other unemployed in the future.

Thanks again for the project, it works!

Port Adelaide Information Technology Centre (ITeC),
Port Adelaide, SA.

DPM project - 2

I read with interest the article in June *EA* on the simple digital meter. It is a creditworthy design, but I feel some clarification about the 'competing' one-chip solution 7106/7107 may be helpful.

The authors claim they require an external clock. This is not so; they both have an internal clock like the MC14433. They are housed in a 40-/pin DIL, not 28 as mentioned, due to the fact that they provide DIRECT rather than MULTIPLEXED drive.

Another significant point is that the 7106/7107 have an on-chip band gap reference, unlike the Motorola part. The 7106/7 Vref exhibits a typical tempco of 80ppm, whereas the 3V3 zener will give about 700ppm – according to data for the Philips BZX55, a typical 400mW zener. Actually this type of general purpose zener exhibits its best tempcos at 5.1V, where 150ppm is

typical – although it can't be used on a 5V rail obviously!

The direct versus multiplexed drive has some ramifications also. If the meter is to be used in conjunction with low level analog circuitry, say audio or RF equipment such as distortion meters or amplitude monitors, the multiplexer 'buzz' from the pulsed LED current can cause problems by coupling to these circuits. The drive from the 7106/7 has no rapidly fluctuating currents and is therefore 'quiet'.

For LCD drive the 7106 is first choice – to use the MC14433 with LCDs, no fewer than seven extra ICs are needed according to Motorola's application note! On the other hand the MC14433 is best if the BCD output data format is needed for a data logger or computer input, for example.

The final point concerns the type of capacitor used in the integration section of both types of IC. We have found that general purpose PET (poly ethylene terepthalate) capacitors are quite OK for 3-1/2 digits, but we built a 4-1/2 digit DVM using the TSC7135 from Teledyne Semiconductors and found that PET was NBG!

A neat way to check the performance of the integration capacitor is to connect the input of the DVM directly to its own Vref – whereby the resulting display should be 1999. Any significant hysteresis effect or losses in the capacitor will give a reduced reading.

Keep up the good work!
Clive Chamberlain, MD,
Australian Test & Measurement,
Artarmon, NSW.

Testing risk

I have a student who had built up a kitset frequency counter.

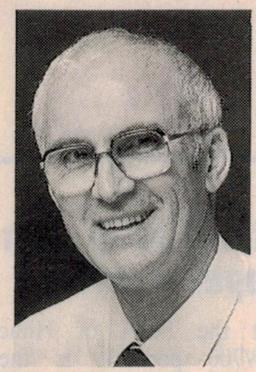
The instructions state 'connect it to a TV set to measure the 4.43MHz colour oscillator to calibrate the counter'. No mention was made in the article (I have been told) that most CTV chassis are live to the mains.

This counter was connected to a Philips 14" remote KT3 – A3 colour TV. As a consequence it destructed the TV power supply, horizontal output stage, sync stage and chroma stage as well. The student concerned was lucky that he was not as dead as the chroma IC, which had blown itself open.

Safety aspects of construction projects must be considered in all aspects when amateur constructors follow instructions to the letter in (Australian) magazines.

Rod Humphris,
RMIT, Melbourne, VIC.

EDITORIAL VIEWPOINT



Plenty of reading, whatever your interest

I think you'll find that this month's issue has even more absorbing and timely reading than usual, whatever your main areas of interest.

For example we have a very interesting story on NASA's new Hubble Space Telescope, by Kathryn Doolan, looking at both the background to its development and the technology it uses. There's also a story by Tom Moffat on Australia's new Antartic research ship the *Aurora Australis*, and its state of the art electronics gear. And another story by Stewart Fist, explaining why the Australian-developed 'QPSX' data networking system is attracting interest from around the world.

In the area of entertainment electronics, Louis Challis reviews the new Philips CD-840 CD player using that firm's 'Bitstream' D-to-A conversion. And Barry Smith looks at the Arriflex 535 motion picture camera, which turns out to be simply 'loaded' with electronics.

Our technical feature this month is on printer technology, and this includes a hands-on review of Texas Instruments' new and compact 'microLaser' – which offers full PostScript facilities for significantly less than earlier models. There's also a very interesting story from Hewlett-Packard, on the techniques HP developed to achieve higher printing resolution.

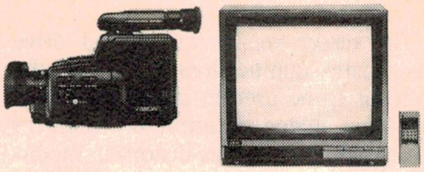
Coming to electronics construction projects, we have the first instalment of Rob Evans' description of his new top-performance stereo preamp, designed as a fitting companion for his impressive 'Pro Series No.1' power amplifier. There's also a simple tester design for infra-red remote control units, the second article describing my own 'VHF Powermatch' testing system, an easy to build beam antenna for the 52MHz amateur band, and a follow-up story on Branco Justic's very popular IR Night Viewer design.

Add to these the latest chapter of Peter Phillips' series on Basic Electronics, the second part of Peter Jensen's story on Syntony and Spark, and of course all our usual columns and departments. If you can't find something to interest you in that lot, it won't be for want of trying on our part...

In fact a few days ago I received a letter from a reader complaining that the magazine now provides *too much* reading each month. It isn't often that an editor gets that kind of response – when there are complaints, they're usually that there isn't *enough* interesting reading. I guess no matter what we do, we'll never please you all!

Jim Rowe

What's New In
HOME ELECTRONICS



Hitachi midi with 'Super woofer'

At the heart of Hitachi's model CXW700 portable is the 'Acoustic Super Woofer' system, which features three separate sealed speaker enclosures.

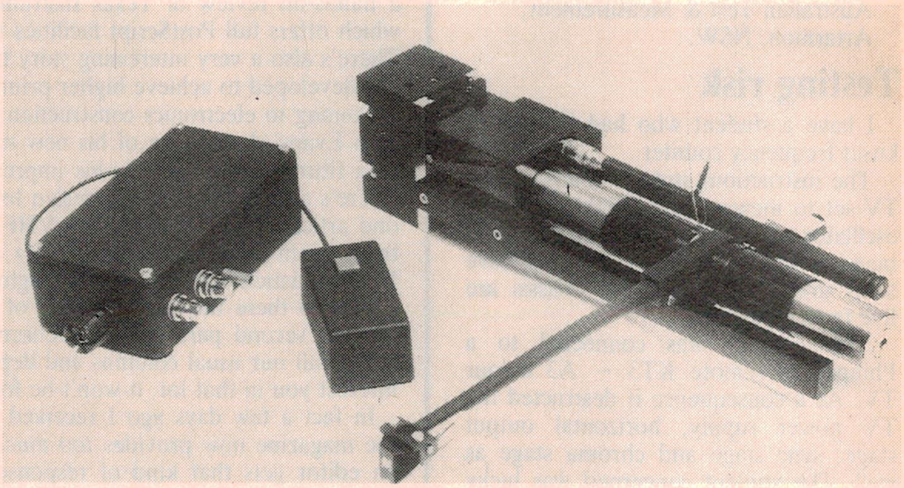
Both left and right channels are now also virtually free of reverse phase cancellation, with the addition of an extremely effective surround sound system to further emphasise clear channel separation.

The third enclosure houses the acoustic super woofer, which in effect, is similar in design to a component hifi sub woofer box – incorporating a tuned port to pump out bass frequencies down to an impressive 50Hz. The unit also incorporates a fully programmable compact disc player.

The CXW700 also has many other features, such as a four band tuner and twin tape decks with full auto stop function, high speed dub and auto-reverse playback. A 3-band graphic equaliser allows flexible control of output sound quality. The provision of CD line out and microphone mixing virtually turns the CXW700 into a complete home recording system.

For further information contact Hitachi Sales Australia, on (03) 555 8722.

Pickup arm has air bearings



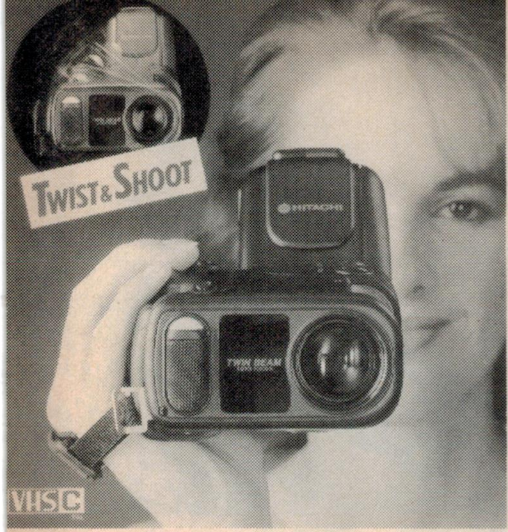
For the most accurate tracking and hence minimum playback distortion, a pickup arm for conventional LP's should move radially in a linear manner – retracing the path of the recording cutter. However most attempts to produce such parallel or 'tangential' tracking arms have ended up with higher bearing friction than the more common arms with a simple pivot system.

Swedish tonearm designer Leif Haggmark claims to have solved this problem with his Audionord 'Airtangent II' air-bearing tonearm. With an air bearing said to have an effective area of 78cm square, the arm combines 'immeasurable' bearing friction with a high level of guiding stability. In operation, air pressure from a small pump is used to stabilise the position of the cartridge carrier arm, achieving virtually no detectable 'play'.

The cartridge carrier is a short tapered magnesium tube, with a simple rear counterweight to set tracking force. This is said to give a low effective mass at the stylus.

The Airtangent II is available in two models – 1B and 2B. The higher performance model 2B includes silicone damping used to inhibit low-frequency arm resonances, and an electronically controlled cueing bar is provided for convenient raising and lowering.

Prices for the Airtangent II start at $3995 for the model 1B, with a 5 year parts and labour warranty. Further information is available from Australian distributor The Audio Connection, of Old Town Plaza, Bankstown 2200 or phone (02) 708 4388.



Thinnest VHS-C video camera

Weighing in at only 970g, the Hitachi VMC1E is claimed to be the answer to a traveller's dream. Combining the convenience of light weight design with a slimline profile of only 69mm, the VMC1E is possibly the thinnest VHS-C camera on the market.

All the operational controls have been cleverly incorporated in a flush 'body hugging' design minimising the possibility of damage. Even the lens has an automatic protective cover to reduce the possibility of accidental damage or dust collecting on the lens surface.

To activate the VMC1E, you simply release the locking mecahnism. A twist of the hand grip then brings the camera to life. Focus, white balance, iris and shutter speed are now automatically controlled and ready for action.

Hitachi has developed a new twin beam infra-red focusing system for the C1E that ensures fast accurate auto focus of the X6 zoom lens. The lens's macro mode will also function from within 50cm of the lens.

Selection of either SP or LP modes allows up to one hour of recording time via amorphous video heads. The VMC1E also incorporates a colour image generator.

For further information contact Hitachi Sales Australia on (03) 555 8722.

Open reel recorder

Fostex has upgraded its G-16 , 16-track half-inch open reel recorder, which now offers additional features. It also provides quiet and more efficient operation as all solenoids have been replaced by a smooth, motorised cam action.

A jog-shuttle wheel offers precise control over tape location, while spot erase permits close attention to ¡recorded detail. Extensive memory, locate, and zone limit functions ensure rapid operation. There are two counter displays which show setting time and real time; when reading SMPTE time this is used for both counters.

In addition, the G-16 offers an optional built in synchroniser, with a built-in generator function so the recorder can feed SMPTE at fast wind or play mode to an external machine. It can read external time code at high speed (x100 times) and can then chase it. In addition, it will 'listen' for and respond to midi time code commands if required.

The audio circuits feature very high headroom – 10 times the normal operating level is maintained throughout the audio path. This ensures excellent transient response. The unit also features 'Dolby C', the industry preferred noise reduction system for narrow gauge Multitrack. All line up controls are fully accessible from the remote panel. Signal and record/play function switching is fully automatic and follows standard studio protocols.

For further information contact Tradepower International, 29A Glenvale Crescent, Mulgrave 3170 or phone (03) 560 9111.

Programmable double cassette deck

Onkyo's TA-W200 is a microcomputer controlled double cassette deck offering many features, including the convenience of making your own quality tapes for your car tape deck and your portable cassette radio.

Both Dolby B and C noise reduction systems are incorporated in the TA-W200. Having the choice of two noise reduction (NR) systems is important when considering compatibility. This is because a Dolby B encoded tape will most certainly be compatible with your car stereo and portable radio cassette, while Dolby C noise reduction offers a greater dynamic range.

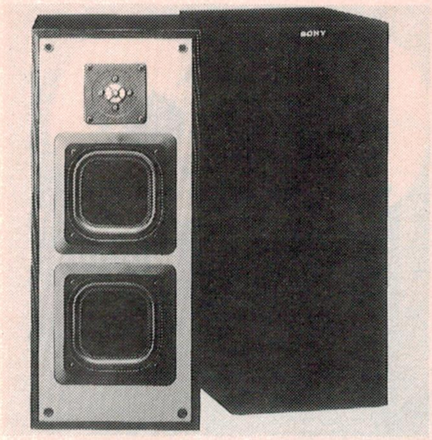
The TA-W200 further offers the Dolby 'HX Pro' headroom extension system, which works by continually monitoring the audio signal and lowering the bias current as sound peaks are encountered. Dropping the bias level allows the tape to accommodate a large high frequency transient without saturating. Once the transient is passed the recording bias is instantly restored to the correct level. Onkyo claims this is a major benefit when recording from today's digital sources such as the compact disc player, which produces very high levels of high frequency energy.

The TA-W200 deck uses full computer control logic and dual motor tape transport systems. It will automatically select the correct equalisation and playback characteristics for normal, high or metal position tapes.

Further, it uses Onkyo's proprietary remote interactive control system, so that all major cassette deck functions can be addressed via the remote controller.

The TA-W200 is covered by a five year parts and labour warranty and has a recommended retail price of $499.

For further information contact Audio Insight, 5 Skyline Place, Frenchs Forest 2086 or phone (02) 975 3011.



Additions to Sony 'ES' speaker range

Sony Australia has released four new models to add to its 'SES' speaker range. All four models were designed, developed and constructed in Europe.

All four new models have borrowed technology used in aerospace applications: a honeycomb diaphragm covered with a thin aluminium skin that is more than 1000 times stiffer than ordinary designs.

The top of the range is the APM181ES, a three-way design. It uses a high quality 'nitrided' titanium tweeter to deliver clean treble response up to 20kHz. A 100mm cone handles the midrange and a 196sq cm APM (accurate pistonic motion) driver provides deep, powerful bass. It is suitable for amplifiers delivering 25 to 120 watts RMS.

Next is the APM141ES, which features a twin bass driver system. Supported by two 121 sq cm bass/mid-range drive units, this reflex design delivers a remarkably full bass as well as high end reproduction from its 19mm titanium dome tweeter. It is suitable for amplifiers with a power output of 25 to 90 watts RMS.

The APM121ES is finished in black ash and is a two-way model that provides a bigger sound than its diminutive size would imply. It features a 19mm titanium tweeter, a 144 sq cm APM bass driver and gives the more discerning listener the option of bi-wiring to realise its full stereo imaging potential.

Finally there is the APM101ES. An efficient bookshelf design, this uses a 121sq cm APM bass driver coupled with the 19mm titanium dome tweeter. Recommended for amplifiers of between 15 and 60 watts RMS, the APM101ES makes the perfect choice when space and financial constraints occur.

Quoted prices are $999 for the 181ES, $699 for the 141ES, $499 for the 121ES and $399 for the 101ES.

For further information contact your nearest Sony dealer or phone (02) 887 666.

Easy to use camcorder

Sharp's new VLC-770X camcorder has a 12X variable zoom lens, providing the equivalent to a 500mm lens on a still camera. It uses the VHS-C format which is compatible with VHS, allowing the user to play back directly through the VCR.

The VLC-770X has a full auto button, which switches on auto focus and auto white balance and lets the user concentrate on the scene. There's also audio/video fade in/out, audio dubbing and a picture insert function, plus a flying erase head – making the VLC-770X one of the most up-to-the-minute camcorders on the market, according to Sharp.

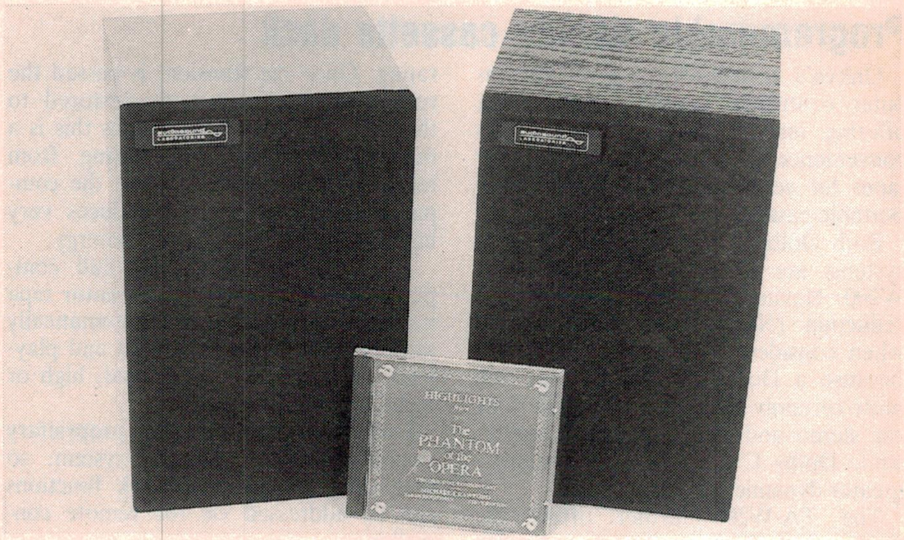
For further information contact your nearest Sharp dealer or phone (02) 296 558.

Australian mini speakers

Audiosound Laboratories have introduced a new high-performance mini speaker system covering both domestic and professional requirements where high-quality, wide-range sound if required from a very small enclosure.

Measuring only 30.5 x 19cm, the new Australian made system comes in two versions and two cabinet styles. Designated 8012 and 8013, they are both available with different cross-over filters. 'B' version of each also carries a higher power rating, for amplifiers up to 75 watts RMS.

The 8012 is finished in black simulated woodgrain while the 8013 is in a high-glass eurothane available in any colour to match a particular surrounding. Both systems employ the same driver complement as Audiosound's popular 8033A control monitor – 150cm linear woofer and 25mm wide-dispersion



dome-unit – and have a low frequency roll-off of –3dB at 70Hz and –6dB at 65Hz.

Prices range from $629 a pair for the 8012 to $889 a pair for the 8013B, which according to Audiosound is a little over one third the cost of similar performance imported monitors.

For further information contact Audiosound Laboratories, 148 Pitt Road, North Curl Curl 2099 or phone (02) 938 2068.

Yamaha brings you the most innovative entertainment technology since moving pictures...

Moving sound.

Prepare yourself for a very special audio and video experience.

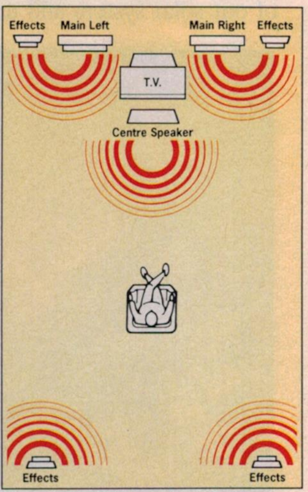
With Yamaha's innovative Digital Sound Field Processor technology, you can recreate the excitement of actual live performance venues and cinema sound, right in your own living room.

Digital Sound Field Processing precisely recreates the special ambiance of these environments, for a breathtaking listening experience.

At the touch of a button you can have the acoustic characteristics of a European concert hall, a Jazz club, an open air Rock venue, a Disco, a Church or even an Opera house.

Yamaha's exciting 'Moving Sound' system: The DSP-A700 amplifier and it's companion AVS-700 selector, centre speaker, main speakers and the smaller effects speakers.

When watching video, just select DOLBY* PRO-LOGIC SURROUND to recreate the magic of the cinema.



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READER INFO No. 48

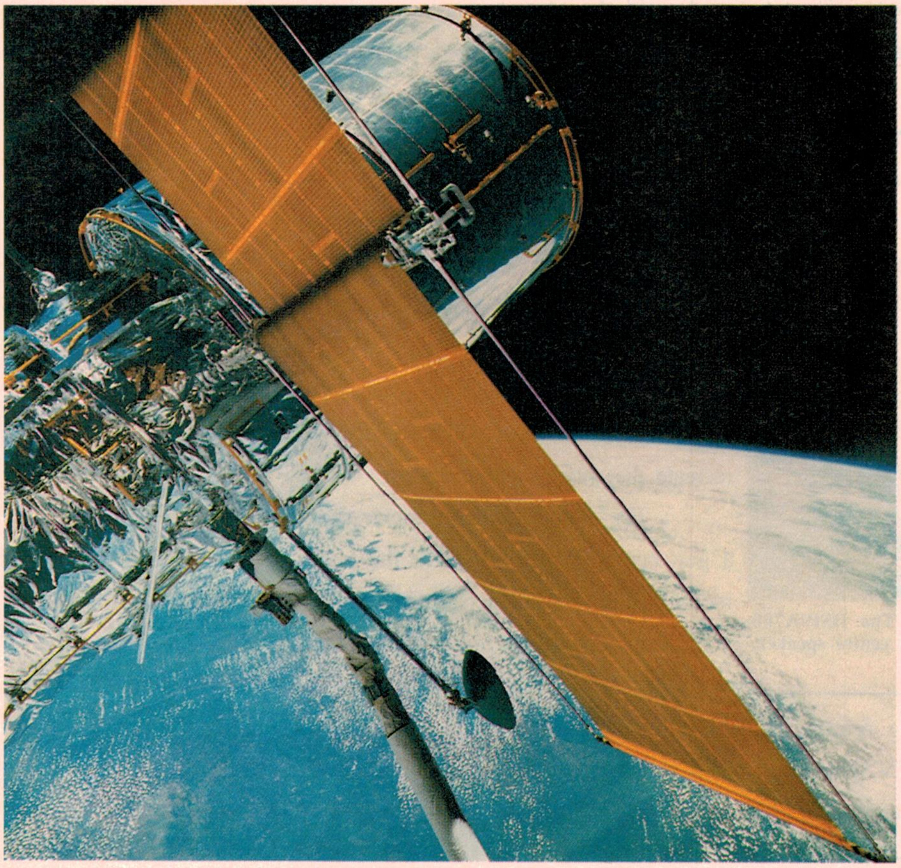
NASA's Hubble Space Telescope:

THE ULTIMATE TIME MACHINE

After more than its share of delays and hitches, the Hubble Space Telescope is in orbit and due to become operational next month. Astronomers around the world – including Australia – are eagerly looking forward to the day when it will take them where no astronomer has gone before.

by KATHRYN DOOLAN

Today, astronomy is on the verge of a new era. After years of delays and problems, the Hubble Space Telescope (HST) is finally in Earth orbit and has already started to unlock the mysteries of our solar system and universe. At the time of writing, the first images have been returned from this remarkable machine and astronomers are eagerly awaiting for next month (October) when the HST finally becomes operational.



One of the first pictures released after the Hubble was launched, showing the view from the Shuttle as the solar panels were deployed.

As with most American space projects since the late sixties, the Hubble Space Telescope has been at some time or another: a political football, cut altogether from NASA's budget or a far-off dream that would never come true. It was further delayed by the Challenger accident in 1986, but the HST is now in space, nearly 10 years behind schedule and millions of dollars over budget.

The idea of having a spacebound telescope is not a recent one. In the thirties, German rocket scientist and pioneer Hermann Oberth suggested that having a large telescope in Earth orbit would give astronomers an unobstructed view of the universe as a whole and would provide new opportunities in solving the answers to astronomy's greatest questions.

In 1946, Princeton University astronomer Lyman Spitzer became an advocate of having a large space telescope with an aperture of 3m (120″) and in continuous Earth orbit at an altitude of 300 miles. Spitzer also envisioned that the telescope would be in constant use by both professional and amateur astronomers, 24 hours a day.

In the glory days of NASA in the sixties, the space telescope was a frequent item on scientists agendas but for the most part, remained a discussion piece. It was not until 1969 that the Space Science Board of the National Academy of Sciences called for a large telescope to be placed in orbit by the late seventies.

Following the lunar landing in July 1969, there was a massive turning away from space and NASA's budgets were

slashed. NASA was then placed in the unaccustomed position of fighting for funds and also had to justify future projects as economically feasible. This policy had dire effects on the fledgling Space Shuttle program and was to prove disastrous in later years, to both manned spaceflight and space science.

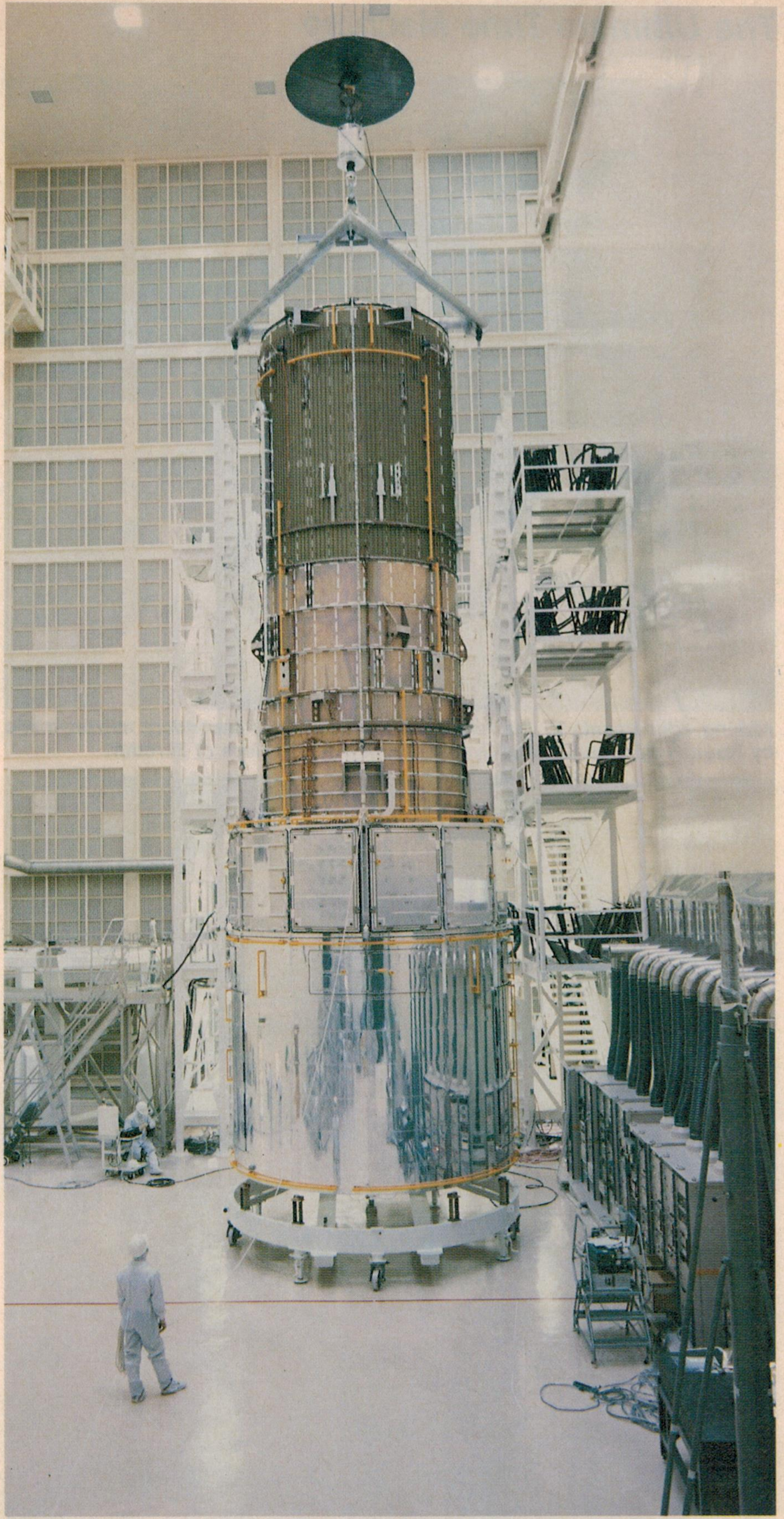
In 1972, the National Academy of Sciences released a study which reviewed the priorities and needs of astronomy for the remainder of that decade, and again recommended a large orbital optical telescope. At the same time, NASA convened several small teams of astronomers to provide guidance for groups at the Goddard and Marshall Space Flight Centres who were conducting feasibility studies for space telescopes.

In 1973 NASA established a scientific and engineering steering committee to determine scientific objectives for the space telescope. In 1975, the European Space Agency (ESA) became involved with the project and agreed to pay 15% of the space telescope's costs in return for an equal proportion of observing time and access to data from other scientific instruments. ESA also agreed to build the solar arrays and one of the scientific instruments, and to contribute manpower to the project.

After a somewhat bitter fight to gain funding from Congress, in which scientiests became politically active for the first time and lobbied individual representatives and sentors, Congress finally approved funding for the Large Space Telescope in 1978. However along the way, the telescope's aperture was reduced to 2.4 metres (94") and the telescope was to be known as the 'Space Telescope' and not the 'Large Space Telescope'.

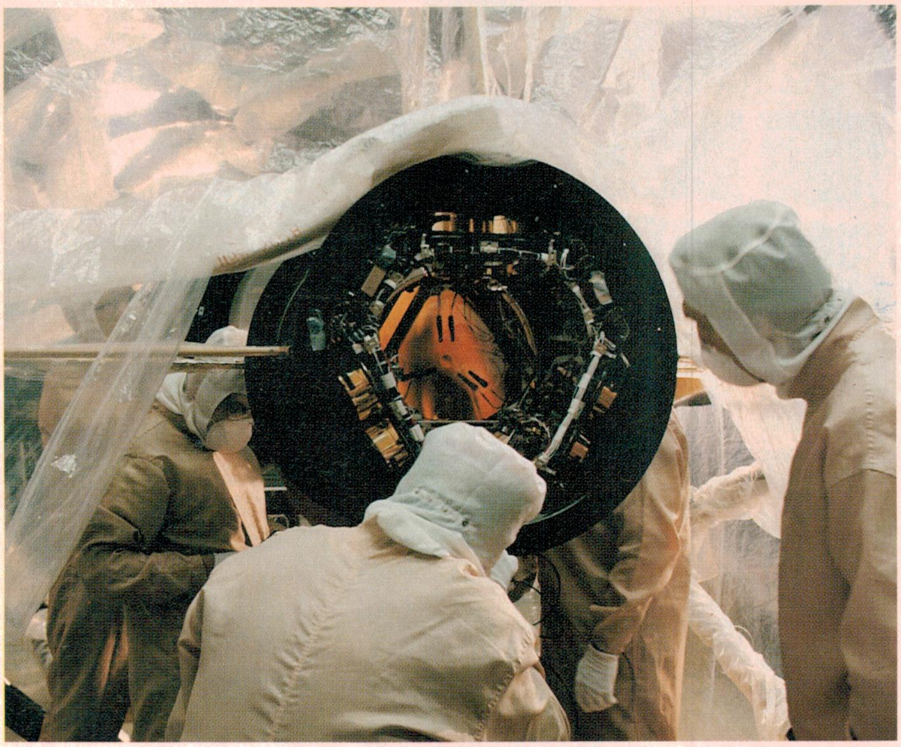
. Named after the eminent American astronomer Edwin P. Hubble (1889-1953), who discovered the expanding nature of the universe theory and the true nature of galaxies, the Hubble Space Telescope has been designed as the first long term and repairable space observatory. The HST will be able to detect starlight that has travelled for billions of years and it has been suggested that it may see events that occurred close to the beginning of the 'Big Bang' (the moment of creation).

The telescope is 13 metres long and weighs in at 11,600 kilograms – 11.6 tonnes. It orbits the Earth at an altitude of 607 kilometres, at an inclination of 28.5°. The HST has two mirrors: the main mirror which is 2.4m in diameter and the secondary mirror which is 0.3m in diameter. With an expected lifespan

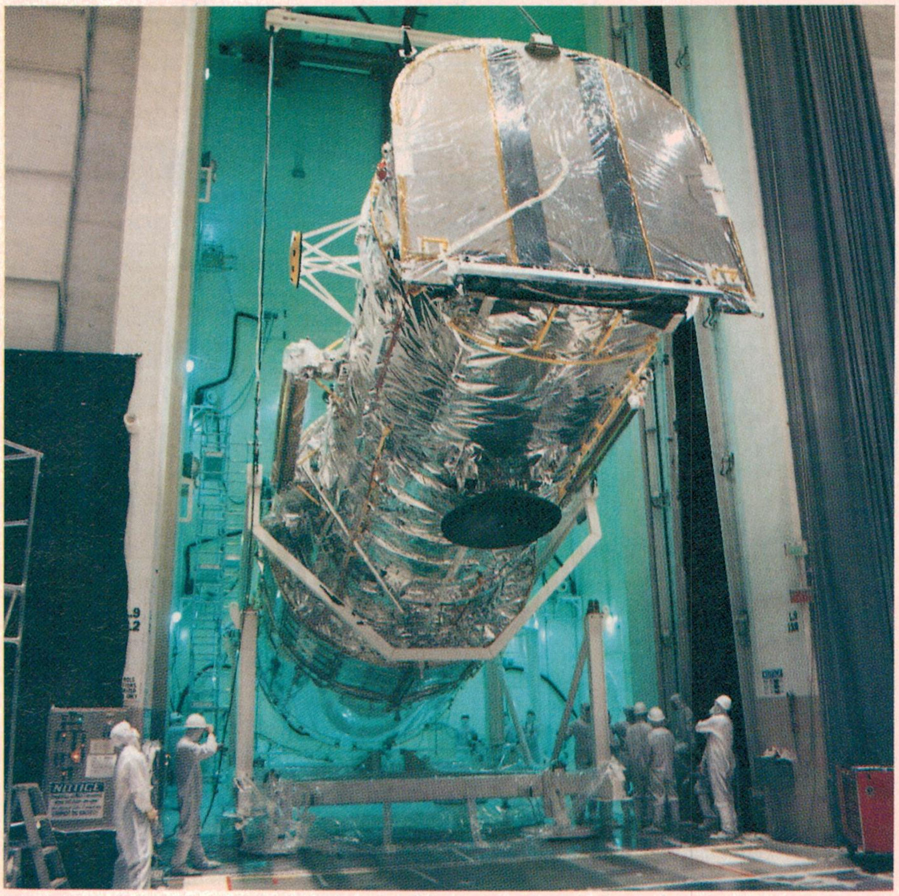


A shot taken during the final assembly, giving a good idea of the telescope's size – 13 metres long, and with a mass of 11.6 tonnes.

The Ultimate Time Machine



Making adjustments to the telescope's 330mm (13") secondary mirror, made by Hughes Danbury Optical Systems from a single piece of Zerodur.



Manoevering the telescope assembly out of the lab, for transport to the Shuttle for launching. Note the protective wrapping.

of 15 years, the Hubble has been designed so that spacewalking astronauts can repair or replace worn-out or obsolete equipment.

The major elements of the Hubble Space Telescope are the optical telescope assembly (OTA), the six scientific instruments – the European designed Faint Object Camera, the wide Field/Planetary Camera, the Faint Object Spectrograph, the High Speed Photometer, and the Goddard High Resolution Spectrograph – as well as the Support Systems Module (SSM) which houses the electronics, electrical support systems and scientific instruments.

The Optical Telescope Assembly consists of the primary and secondary mirrors, support trusses and the focal plane structure. Incoming light travels down a tubular baffle which absorbs any unwanted stray light; it is then reflected by the primary mirror and travels to the secondary mirror. After that the light is then reflected by the secondary mirror to a hole in the primary mirror and to the focal plane, aft of the primary mirror. This is where the scientific instruments receive and process it.

The two mirrors that are used by the telescope are probably the smoothest mirror surfaces ever developed. The mirrors that were designed for the HST had to be built from scratch, as surface deviations exceeding more than half a millionth of an inch were not permitted. To meet this criteria, instead of using solid glass the optical engineers designed the mirror with a honeycomb shell so that it would weigh considerably less.

If the mirror were to be made of solid glass, it would have weighed nearly three tonnes and would have been impossible to launch into orbit aboard the shuttle. By using the honeycomb structure, engineers eliminated 75% of the mirror's weight.

Once the mirror was completed, it was then coated with a layer of reflective aluminium to enhance its surface.

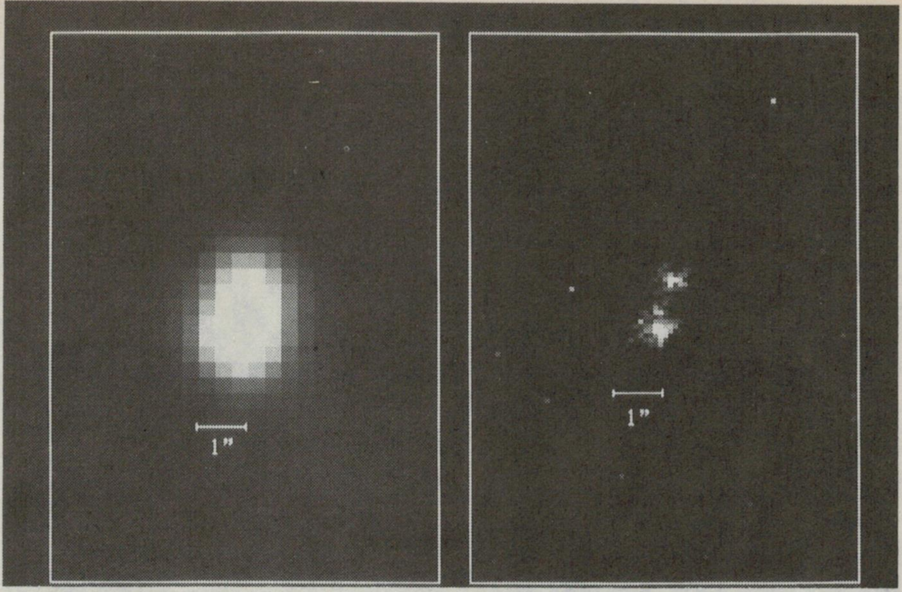
The Hubble is powered by two solar arrays located on each side of the telescope. Each of these arrays contain 48,000 solar cells which convert the Sun's energy to electricity to power all systems. When the telescope is orbiting through darkness, power is stored in six nickel-hydrogen batteries.

Instruments

The Wide Field/Planetary Camera (WF/PC) has two purposes. In the wide field mode, its field of view will permit it to take images of dozens or maybe hundreds of distant galaxies at once. In

the planetary mode, it will provide photographs of all the planets in our Solar System – except Mercury which is too close to the Sun for the HST to point at. It is expected that the images of distant planets Jupiter, Saturn, Uranus and Neptune will be comparable to images taken by recent Voyager 1 and 2 flybys.

The European-designed Faint Object Camera (FOC) will help extend the reach of the Hubble Space Telescope to its greatest possible distance and produce the sharpest images. Many galaxies and stars which are barely perceptible to Earth-bound telescopes will appear as dazzling sources of light to the Faint Object Camera. It is expected that the FOC will intensify images to a brightness 100,000 times greater than when the light was first received by the HST. The FOC will also be used to determine the distance of the universe as a whole, study binary stars – two close stars that appear to be one – and peer into the centre of globular star clusters.



Despite mirror problems, an early image from HST's wide field/planetary camera (R) still compares favourably with that from the ground-based telescope at Las Campanas Observatory (L) in Washington, for the same object.

The High Speed Photometer (HSP) is a simple but accurate light meter that will measure the magnitude of objects being observed as well as any variations in that brightness with time, in both the visible and ultraviolet spectrums. One of the HSP's main tasks will be to look for clues that black holes could exist in binary star systems. Variations in brightness could occur as one star revolves around the other. Irregularities in that variation may indicate that matter is being lost to a black hole, which is so dense that nothing, not even light may escape from it. The photometer will also provide accurate maps of the magnitude of stars.

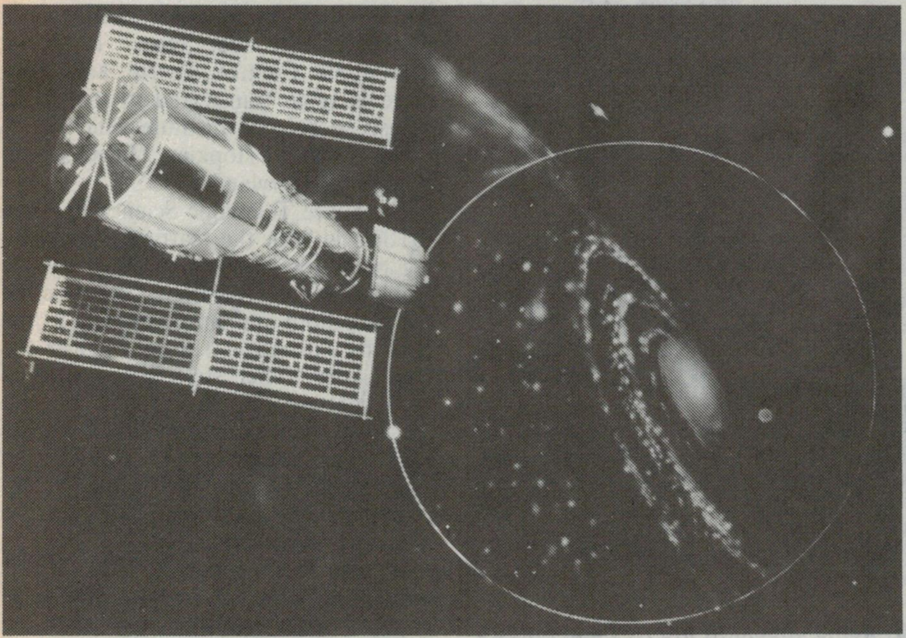
There are two spectrographs aboard the Hubble Space Telescope. A spectrograph is not a camera as such, but it takes a 'chemical fingerprint' of the object being observed, separating the radiation received from an object according to wavelengths. Each chemical element produces its own individual pattern, so when the 'fingerprint' is analysed, scientists know what elements are contained in the object being observed.

The Goddard High Resolution Spectrograph is the only scientific instrument on the HST dedicated to studies of ultraviolet light. The detectors are designed so that the GHRS is insensitive to visible light, as ultraviolet emissions from stars are usually hidden by the bright visible light emissions. The 'high resolution' name in the instrument's title refers to the ability to study the spectrogram in great detail.

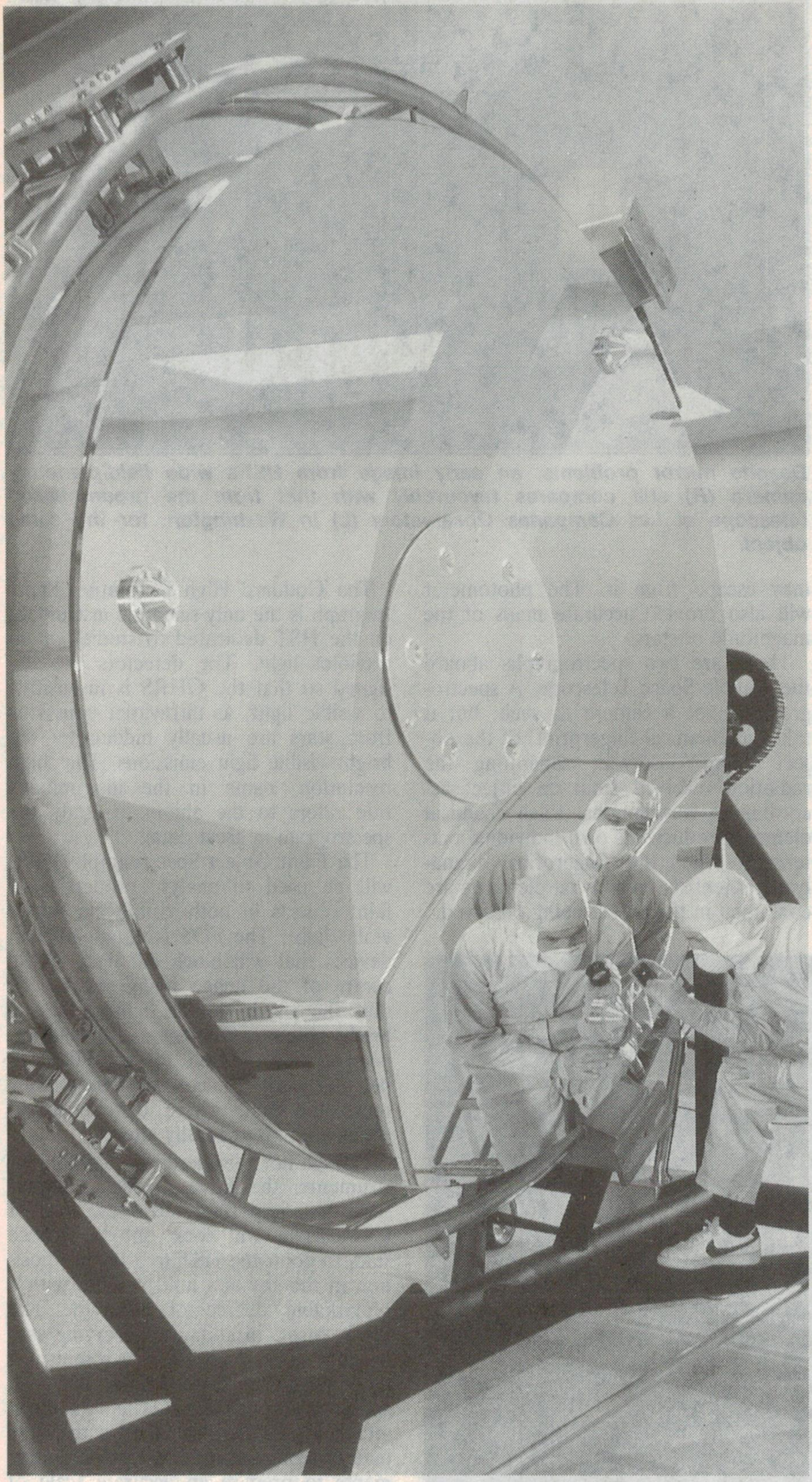
The Faint Object Spectrograph (FOS) will be used to analyse properties of faint objects in both visible and ultraviolet light. The FOS is equipped with devices that will block out light at the centre of the image being viewed, so that the much fainter light around a bright object can be observed. One important area of study for the FOS will be the study of comets before they reach the Sun, where their chemical composition is generally altered.

Though not considered as scientific instruments, the three guidance sensors serve two important purposes. Two of the sensors will lock onto reference stars to point the HST to a precise position in the sky and hold it there with a remarkable degree of accuracy. The third sensor, in addition to serving as a backup, will be used for astrometry – the science of measuring angles between astronomical objects. The measurements obtained will be used with information from the other scientific instruments to prepare an accurate scale of the universe.

To communicate with scientists and eingeers on the group, the HST has



An artist's impression of the HST in orbit with solar arrays extended, mirror cover open and pointed at a spiral galaxy.



Technicians at Hughes Danbury Optical Systems checking the HST's 2.4-metre primary mirror. The surface coating is a layer of pure aluminium 64 nanometres thick, covered by a 25nm protective film of magnesium fluoride.

been connected to the Tracking and Data Relay Satellite System (TDRSS). There are currently two operational TDRSS satellites, one being located over the Pacific Ocean (TDRS-W) and the other over the Atlantic Ocean (TDRS-E).

The HST is one of the first users to require both the Multiple Access (MA) and S-band Single Access (SSA) return services from the TDRSS. The TDRSS (pronounced 'T-Dress') will continuously transfer data through the multiple Access system to the Space Telescope Operations Control Centre at the Goddard Space Flight Centre, and this service will be provided for up to 85 minutes of each HST orbit.

TDRSS will be used to provide SSA forward and return services for each orbit. Realtime science and readouts of the onboard flight computers will be collected through the SSA return service. The forward service will enable the 12,000 commands executed by HST daily to be packaged and transmitted to the two onboard computers that control the spacecraft.

The HST is expected to transmit nearly three billion bits of information through TDRSS daily. This information will be received at the White Sands Ground Terminal in New Mexico, using a pair of 4.9m diameter antennae to communicate with TDRS-E and TDRS-W in either the S- or K- bands, or both. The information is then transferred to the Goddard Data Capture Facility in Maryland, via leased domestic communciations satellites.

Once the information is returned to the Goddard Space Flight Centre, it is transferred to the Space Telescope Operations Control Centre and from there is again transferred to the Space Telescope Science Institute which is located at John Hopkins University in Baltimore, Maryland.

The Space Telescope Science Institute (STScI) is both the starting and finishing point for all data collected by the Hubble Space Telescope. Because of the mammoth amount of interest in the HST by astronomers from all over the world, the STScI staff have arranged very tight and strict schedules to gain the most scientific information from the HST. The schedulers must divide up some 30,000 observations within the approximate 3000 hours of viewing time to be available each year.

To gain viewing time on the HST is not an easy exercise. Institute staff have imposed strict guidelines on what the telescope can be used for. Observations not permitted include viewings of the

Sun, Moon or Earth, as the light given off by these objects would totally destroy the mirrors. The allocation of viewing time is controlled by a peer review system, in which astronomers are judged by fellow astronomers on their proposals and then the proposals are judged for their importance and use to astronomy.

One point that will be of interest to Australians is that Australian astronomers have more viewing time on the HST than astronomers from any other country except the United States.

Launching delays

The telescope was due to be launched into space in December 1989, but the US Department of Defence took over that flight, claiming national security took precedence – much to the annoyance of astronomers! The flight was then scheduled for March 1990, but then rescheduled again after faulty O-rings were found in the Solid Rocket Boosters. These had to be replaced.

On April 10, the launch was stopped at four minutes before liftoff as there was a faulty power unit in Discovery's hydraulic steering system. Because the Hubble had only enough internal power to last for a couple of days, it had to be removed form the shuttle's payload bay so that the batteries could be replaced.

Finally, the HST was launched from the Kennedy Space Centre at 8.34am (Florida time) on April 24, 1990 aboard the shuttle Discovery. Accompanying the telescope was the crew of STS 31, comprising Commander Loren Shriver, pilot Charlie Bolden and mission specialists Steve Hawley, Bruce McCandless and Kathy Sullivan.

During the second day of the flight, Steve Hawley prepared to deploy the Hubble while Kathy Sullivan and Bruce McCandless waited in the airlock with their spacesuits on, in case they were called on to do an emergency spacewalk to repair the Hubble. Using the shuttle's Remote Manipulator System (RMS), Hawley slowly and carefully deployed the Hubble into orbit.

For the next two days, Discovery flew in formation with the Hubble in case there were any glitches that would have required an emergency spacewalk or – in the worse case scenario – a return to Earth.

Once Discovery had landed, engineers started to power-up Hubble and test its systems. Several small but worrisome problems cropped up, which had everyone worried about having a billion-dolalr 'lemon' in orbit.

At first the primary antenna was jammed, and it took engineers several days and a trip to the toy store to figure out what was wrong and how to fix it. Using a model of the HST, they used the equivalent of 'pick up sticks' to unjam the antenna – and it worked!

Another worrying problem was that the Hubble was wiggling around too much, but that was solved by slowing the motion of the telescope.

Another more recent hitch was the problem engineers were having with the Fine Guidance Sensors, which were not locking onto stars to make observations. This problem delayed the return of the first images by almost a week. One NASA official has pointed out that the Hubble will take six months to become operational and people should not be worried by the problems, which are said to be teething problems and were anticipated.

For the next five to six months, the Hubble will be undergoing extensive testing and the only images produced will be planetary ones. With the testing program, engineers expect to become more familiar with the Hubble and will learn how to use it to gain the best results.

One of the earliest Hubble observations will be those of the tiny Pluto. It is expected that the HST will assist astronomers in learning more about this planet, which to Earth-based observers looks like a small speck of dust.

Another interesting observation could be the search for the long-awaited tenth planet, which has until now just been speculation among astronomers.

Once the observations begin to look out to the distant stars, astronomers will get the chance to observe Supernova 87A – the first supernova seen by the naked eye in early 400 years. When the Supernova first erupted back in 1987, the Hubble was sitting in a clean room on the ground, and astronomers tore their hair out over the fact that the Hubble was not observing it.

All of this does not come cheap. The construction cost of the Hubble is now standing at US$1.8 billion and it will cost another 300 million dollars to operate the HST over the next 15 years. Another 300 million dollars will have been spent on the design and development of the equipment. However, this sum is small compared to the recent debut of the 'Stealth' bomber, which comes in at US$135 million each – and the Pentagon has requested 800 of them over the next 10 years!

But at long last, the Hubble Space Telescope is finally in space. It looks set to be the most significant advance in astronomy since a gentleman by the name of Galileo first used a telescope, 400 years ago.

The author would like to thank Jim Elliott, of the Goddard Space Flight Centre, for his assistance in the completion of this article.

STOP PRESS – Hubble Trouble!

After the deployment of the HST in late April, NASA engineers and scientists have been thwarted in their attempts to operate the expensive telescope. The current problem has all but halted the HST's program of observations.

NASA has announced that the problem is due to manufacturing problems with both the primary and secondary mirrors. These were apparently not made to specifications and as a result cannot be used for detecting faint objects or observing very close objects, such as nearby galaxies and planets. Because of money shortages, the HST was never properly tested on the ground; in fact NASA claims it would have been impossible to test it on the ground, because of the design of the telescope and limitations caused by Earth's gravity.

Currently around 40% of Hubble's viewing time will have to be rescheduled until engineers can manufacture lenses that will compensate for the mirror's flaws. It is expected that astronauts will either have to fit the lenses in Earth orbit or bring the HST back to Earth for repairs to be carried out. The earliest this can be done, according to NASA flight manifests, is June 1993.

In the meantime, NASA has launched an investigation. The US Congress has also scheduled hearings which were to start in August – to get to the bottom of the problem and to demand an explanation on why the billion dollar telescope is currently 'orbiting space debris.'

With the indefinite grounding of the Space Shuttle due to elusive fuel leaks, NASA has also had to reschedule all shuttle flights.

Beyond ISDN - or the 'democratic' network

Local area networks (LANs) have been with us now for some time, but a new Metropolitan Area Network (MAN) developed in Western Australia is about to revolutionise the transmission of video, voice and data across the world's cities.

by STEWART FIST

Sometimes it's hard to get excited about telecommunications technologies, when Telecom Australia is still the monopoly supplier in this country. It's not often that some new announcement stirs the deep reservoir of jingoism within.

Usually my jingoism is only vaguely tickled by press releases announcing that we are two weeks ahead of Zimbabwe in the implementation of some obscure form of instrumentation; or those that laud the local design of a cardboard recyclable phone box, or something similar.

But QPSX (Queued Packet and Synchronous eXchange system) is different. This is a West Australian invention, with the economic and technological potential of Ethernet or Token Ring local area networks. The IEEE (Institute of Electrical and Electronic Engineers – usually the first body to formulate telecommunications standards) – has taken QPSX up as the world's new 802.6 MAN (Metropolitan Area Network) standard, and renamed it 'Distributed Queue Dual Bus' (DQDB).

Telecom Australia bought 60% of the company that developed QPSX a few years ago, and the global telecommunications companies have been quick to jump on the bandwagon also. ITT recently took out a licence in the States, Bell Atlantic is beginning trials in Philadelphia, the Germans and the Finns have announced trials, and last year Alcatel, the world's largest telecommunications company, built a DQDB manufacturing plant at Liverpool, Sydney.

So this isn't pie-in-the-sky stuff. Australia has finally made it into the international league with a major new technology, owned and developed within Australia, by Australians. And a lot of the manufacture is staying here too.

What seems to be making all these rather stodgy telecomm organisations excited, is that DQDB (we'd better use the international name!) provides an interim technology between the new ISDN (Integrated Services Digital Network) and the futuristic 'Broadband ISDN'.

It's hard to figure out what the term 'B-ISDN' really implies, but technical types will agree that it involves two distinct concepts: a Metropolitan Area Network (MAN) as the collector and distributor of high-speed data around a city, and a variable-size-packet-switching technique called Asynchronous Transfer Mode (ATM).

MANs and ATM are part of the dream of telecommunications engineers everywhere, to do away with circuit switching, forever. When telecomm bods dream, they see visions of a fish-net-like web of cables across our cities: at each knot in the mesh (at each cable junction) there's a small computerised switch which directs 'packets' of data (carrying voice, video, or text) through the network from originator to receiver. There's no central exchanges, no trunk backbones, and no electro-mechancial switches in the picture – it is an entirely 'connectionless' system.

They also pray for the eventual integration of all telecommunications services (phone, telex, data, videoconferencing, Pay TV, etc), and they know this will only be possible when we have one ubiquitous multi-faceted carrier system, totally flexible in feeder data rates and data types. If they can cram broadcast radio and free-to-air TV signals onto the network, so much the better.

This means totally packetised transmission down optical fibre of course, and their vision involves a big step from the current copper-wire ISDN to these broadband ISDN systems of the future. Fortunately DQDB bridges this gap, and it appears to be capable of working in harmony with both current and future ISDN implementations.

The best way to look at DQDB is to think of it as a very large 'public' local area network (LAN) which can be used to hook up smaller company LANs. It can also handle the transfer of high-speed data between mainframes, along with voice and video conferencing. It uses either a bus (single cable line) or loop (broken circle) architecture.

In a city the size of Perth they'll probably begin the service with only two or three loops and add more later. Sydney will start with dozens and eventually reach the hundred mark, and these will be linked into a metropolitan-wide 'mesh' internet. Later, the major cities will be joined to produce an Australia-wide MAN-internet.

The technology was designed to exploit optical fibre, but it can run over microwave or copper links as well. Existing copper cables will certainly be used as feeder lines from each business user to a 'cluster' or node at its local exchange. The primary optical-fibre loops of the MAN will probably run between exchanges, so that Telecom can provide

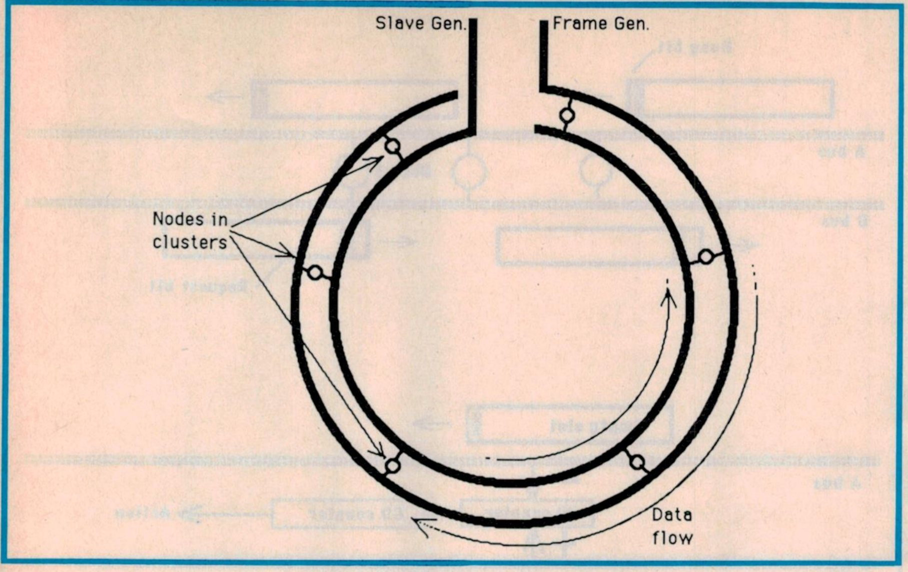


Fig.1: The loop-ladder architecture of DQDB is particularly resilient, and able to isolate faulty nodes in the event of equipment failure.

easy access with feeder lines down existing telephone cable ducts.

Bared down to the essentials, the current implementation of DQDB is a fast packet-switching system designed to run at 140 megabits per second (each way) on a dual fibre highway. You'll have one fibre for traffic going clockwise around the loop, and a second for traffic going anti-clockwise. They need to tap into the network in clusters, because optical pulses require conversion to electrical signals before you can access the data, and you don't want this occurring every hundred yards. However future direct-optical amplification and passive splitting techniques might overcome this problem.

Packet-switching systems are fairly old-hat now, and we tend to think of them in rather antiquated terms. The international X.25 packet-switching network churns along at about 9600bps, and if there are a couple of hundred terminals, sharing half-a-dozen national or international circuits, the network is less than lightning-fast in its response time.

And because each terminal has equal access to a packet-network (but some hog it when they get it) X.25 packet networks are only really useful for non-time-critical data. They're not suitable for digitised voice, because you might hear half a word, then wait a couple of seconds to get the rest. The problem is even worse with video.

So we make the distinction between time-critical communications (voice, video, and time-critical data, say, for automated machine control) and 'more-casual' data that can afford to arrive a second or so late. Circuit-switching has long been considered essential for the first type, while packet-switching technology is more economic for the second.

When telecommunications engineers look at traffic patterns on their present switched networks and leased-lines, they find a lot of unused capacity and this makes telecommunications unnecessarily expensive. Circuits sit idle for a large part of each day, and if you lease the line you can't readily switch it from one branch office to another. A shared data network – a MAN – overcomes the utilisation and connection problems to a large degree.

When we share a MAN, your company's data-peaks may coincide with my company's data-troughs. So, if enough companies are connected, troughs and peaks will always tend to balance. The network can then confidently operate at an average close to 80% or 90% of its rated peak-capacity, and still provide users with quick, unblocked access when needed.

Although it is technically a fast packet-switching system, DQDB can create pseudo-circuits by giving special priority to time-critical packets. Voice and compressed video (2Mbps or less) can be carried over a DQDB network within the stream of more erratic 'packetised' data.

DQDB's network topology (Fig.1) is theoretically linear – – or rather, ladder-like, since they have provided a separate fibre for data travelling in either direction. In practice, the fibre-pairs will be laid through city and suburban areas in a series of large interconnecting loops. This brings the Frame Generator (for one of the fibres) into close proximity with the Slave-frame Generator (for the other). This isn't essential, but it makes life easier.

As with cellular telephone systems, these loops will service 'cells' of different size, and they will be interconnected by routers using ISDN's international E-164 addressing standard. As the average load increases on a local MAN, the loop-cell size can be reduced, and the loop duplicated.

The clusters (access points) for each fibre consist of a photo-detector, a series of OR-gates (one for each access line), regeneration circuits and a laser or light-emitting diode. Each node has four connections – a 'read' and a 'write' pair for each fibre.

The OR-gates (which have very high reliability) ensure that data already on the network can't be overwritten, and they also serve to isolate the MAN from any equipment defects. There's a built-

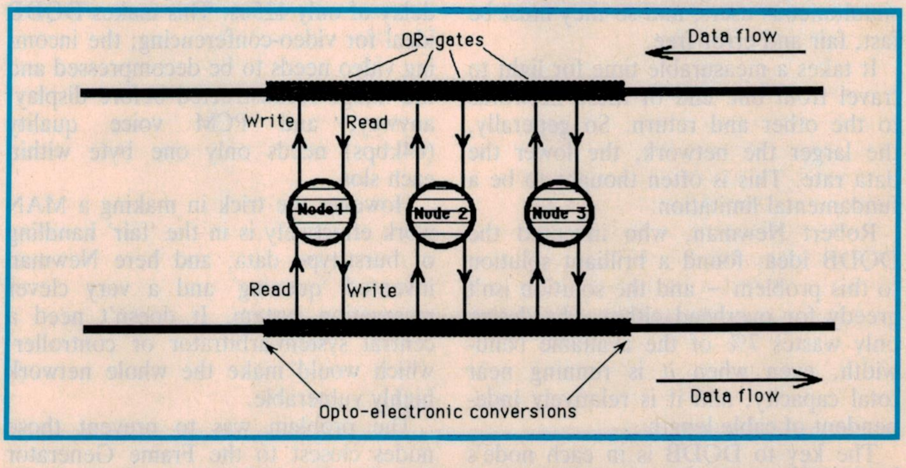


Fig.2: Nodes access the network through clusters, to reduce the problems of opto-electronic conversion.

in self healing process if a cluster is damaged.

The laddered-loop design, combined with the new idea of a queueing (reservation) protocol, is where the real strength of DQDB lies. It overcomes the primary problems all MANs face: how do you allow 'fair' access to a very large general-purpose public network? And how do you avoid constant data collisions, without an enormous cost in overhead?

The nodes in 'contention' schemes (CSMA – Carrier Sense Multiple Access) used in Ethernet and Appletalk, simply wait for a gap in the data-flow, then 'jump in' in an attempt to take control of the network for a fraction of a second to transmit their packets of data. There's no controlling 'arbitrator', and constant data collisions when two or more nodes attempt to transmit at the same time. This free-for-all approach works well on small networks with relatively light data-traffic, but it can't handle time-critical data because there's no guarantee that a node will get regular access to the network.

With token-passing schemes (Token Ring or Token Bus), access to the network is 'deterministic' or guaranteed on a regular basis. But these protocols have high overheads, in passing the token around and in waiting to check the returned signal before passing the token on. This severely limits the number of users, and the length of the LAN.

The IEEE's minimum requirement for their MAN standard was that it must support a geographical area 50kms in diameter, and up to 320kms in path length. MANs are public access systems, carrying data from hundreds of simultaneous users, and so they must be fast, fair and error free.

It takes a measurable time for light to travel from one end of these networks to the other and return. So generally, the larger the network, the lower the data rate. This is often thought to be a fundamental limitation.

Robert Newman, who invented the DQDB idea, found a brilliant solution to this problem – and the solution isn't greedy for overhead either. His design only wastes 7% of the available bandwidth, even when it is running near total capacity, and it is relatively independent of cable length.

The key to DQDB is in each node's ability to read and write to the fibre buses going in each direction. The

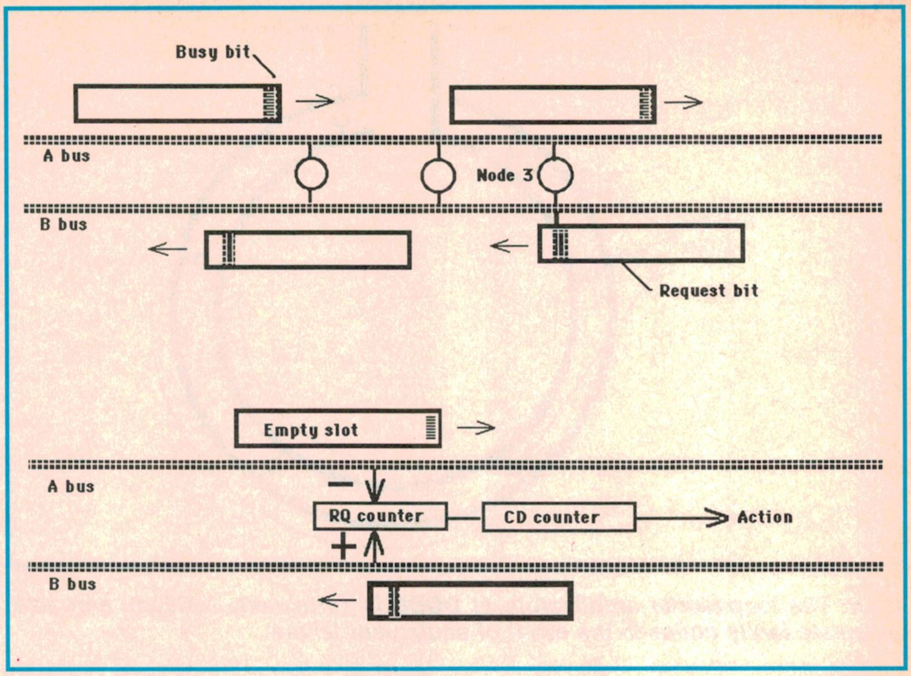


***Fig.3:* When node 3 wishes to transmit, it sets a 'request' bit in a slot travelling in the reverse direction (top) – incrementing downstream RQ counters. Node 3 then transfers its RQ value to the CD counter (bottom). Empty slots decrement the RQ counter as they pass it.**

frame generator on each bus creates a chain of 125us time-intervals, which can be filled by data from the users. This means a throughput of 8000 frames a second on each fibre, and each frame is subdivided into 400 fixed-size slots, each with a 'header' and a carrying capacity of 45 bytes.

The system can reserve some of these slots for 'real-time' (synchronous) voice and video use, effectively providing a guaranteed delivery of 45 bytes every 125us (or more if you reserve extra slots). So just by reserving one slot in every frame, the network can provide a user with a feed-rate of about 2.88Mbps, with a maximum possible delay of only 125us. This makes DQDB ideal for video-conferencing; the incoming video needs to be decompressed and the image reconstructed before display, anyway, and PCM voice quality (64kbps) needs only one byte within each slot.

However the trick in making a MAN work effectively is in the 'fair' handling of burst-type data, and here Newman invented 'queuing' and a very clever reservation system. It doesn't need a central system-arbitrator or controller, which would make the whole network highly vulnerable.

The problem was to prevent those nodes closest to the Frame Generator (or the Slave) from grabbing every available slot, and leaving those nodes further 'upstream' with no slots to use.

Newman's solution was to have each node make a reservation, by setting a REQ (request) bit in a frame passing in the *opposite* direction (Fig.2). If the node wants to transmit in a clockwise direction, the REQ bit is set in the header of a slot going anti-clockwise. As this frame travels 'downstream' it will be passing all nodes on the network that could potentially gobble up free slots and so prevent fair access; the REQ bit tells them that a node further 'upstream' has made a reservation and they must wait.

REQ bits are read and recorded by each node's 'RQ' (request) counter as the frame passes, so each node on the network is keeping its own check on reservation requests. At the same time the RQ counter decrements every time a vacant slot passes it heading in the 'upstream' direction. That is one less reservation it must provide for.

In effect, each node steps back and lets vacant slots pass by while there are more reservations than vacant frames. When the node's counter reaches zero, it knows that all prior reservations have been satisfied and it can jump in and grab the next slot that comes along.

I commend this idea to the State Rail Authority for peak-hour in Sydney; it is brilliant! Anyone getting on a north-bound train at Central can always get a seat, but if you get on at Wynyard

you've got 'Buckleys'!

All this sophisticated network control is exerted in a completely decentralised way, and with an overhead of only two bits per slot – one is the REQ bit, and the other says "I'm vacant" or not (actually more are provided).

This is a slight over-simplification, but it helps you to appreciate the principle. There are actually two counters at each node, for each fibre. The RQ (request) counter keeps a constant check-balance of reservations and free-slots all the time. However when a node receives data for transmission, the RQ counter passes its current value to a CD (count-down) counter, and it is zero on this counter that initiates the slot-grab.

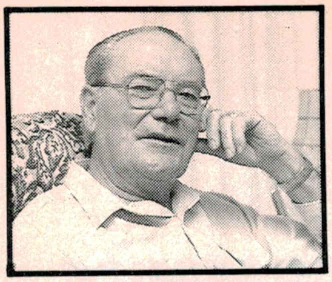
The beauty of this queueing approach is that there is no token-passing overheads, no random waiting time, no possibilities of data collision, and 100% utilisation of the system up to the point of maximum capacity. The system performs just as well on a network only a few hundred metres in length, or a few hundred kilometres. And it makes no fundamental distinction between synchronous and non-synchronous traffic – but it can be configured to distinguish between time-sensitive and non-sensitive data.

If you know that the network will always be required to carry a certain amount of time-sensitive data, then special priority reservations can be made at the frame-generation stage. There is also the problem of essential system messages and packetised voice, where special priority must be given on the fly. Here you simply modify the reservation counters, allocate priority levels, and add extra identification bits in each slot header.

As it stands, one dual 140Mbps DQDB MAN will probably be able to service about 10,000 ISDN voice and/or data stations, or a lesser number of facilities with higher data volumes. Gateways are being developed to allow it to link with Telecom's DDS, the X.25 packet-networks, Token Ring, Ethernet, CSMA/CD and FDDI fibre optics LANs. Company PABXs will also use the MAN to link branch office switchboards into one company-wide virtual private network.

Newman's DQDB is similar to the proposals being developed by the CCITT for Broadband ISDN, so for a period it will be installed alongside our present ISDN network and then gradually evolve and merge into B-ISDN.

Overall, it's a very impressive Australian contribution to the next era of telecommunications technology.



When I Think Back...

by Neville Williams

George Cookson: from breadcarter to AWA communications engineer

A letter from a reader in Toowoomba, Qld, serves as a reminder that, behind the big-name pioneers that dominate the history of electronic technology, many others have worked faithfully in the background to translate ambitious plans into practical results. Other letters to hand supplement recent references to Professor Ambrose Fleming and to Newcastle electronic organ builder Alan Bourne.

The Queensland reader, Len Cookson, says that his father the late J.G. (George) Cookson was deeply involved, amongst other things, in AWA's early transmitting activities at Pennant Hills, Sydney, in the pioneer broadcast station 2FC, and in updating the New Zealand Broadcasting Board's well known 'YA' transmitters, circa 1934. For good measure, he supervised AWA equipment installation in the huge postwar HF transmitting centre at Doonside.

Like father, like son. Len himself spent most of his working life with AWA, Sydney, from 1934 to 1977 – with 32 of those years spent at the radioelectric works at Ashfield and the remaining 11 at North Ryde.

While I was also employed for a time at AWA Ashfield and at their Head Office in Sydney during the mid 1930s, I'm not aware of having met either Len or his father, although our paths could well have crossed in the course of everyday activities.

According to Len, his father, George Cookson, was born in 1887, the eldest of five sons of a wheat farmer at Dumbalk, South Gippsland, Vic, who helped support his growing family by erecting fences and building local roads and bridges – in his spare time!

On leaving school, George looked around for a less laborious way of earning a living. Half in jest, the manager of a nearby butter factory offered him a job – provided he turned up on the doorstep first thing next morning. George did just that and was given the position.

From making butter, George later became a breadcarter and subsequently married. It was about then that he noticed a magazine advertisement for ICS – the International Correspondence Schools, based in most Australasian capitals.

I remember their adverts in the old days, challenging readers to question whether they were being paid what they were really worth; to consider their aptitude and potential in one of more than 50 possible occupations, and to write for a free illustrated booklet.

As a magazine editor, I used to position the adverts in the layout 'dummy' every month, wondering occasionally how many readers really did write in and really *were* rewarded in the long run with a fatter pay cheque.

Wireless engineer

In fact, encouraged by his mother, George Cookson did write in, did work methodically through the study papers and did end up with an ICS certificate as a fledgling wireless engineer. It was then 1917 and, at that point in time, he joined the Royal Australian Navy and was posted to the coastal wireless telegraph station at Townsville, transferring later to Cooktown.

Len recalls that the family moved to join his father at Cooktown, travelling on the Japanese coastal freighter *Nikki Maru*. When cutlery consistently disappeared from the Cookson table during the voyage, the family was placed under surveillance for possible pilfering. Len himself proved to be the culprit, being caught red-handed hiding cutlery in a crack in the wall!

At Cooktown, his father was a busy man, running the telegraph station and at other times maintaining and operating the projectors at the local once-a-week picture show. In this context, the family was highly supportive of his hard-won technical skills, because they were admitted into the 'flicks' free!

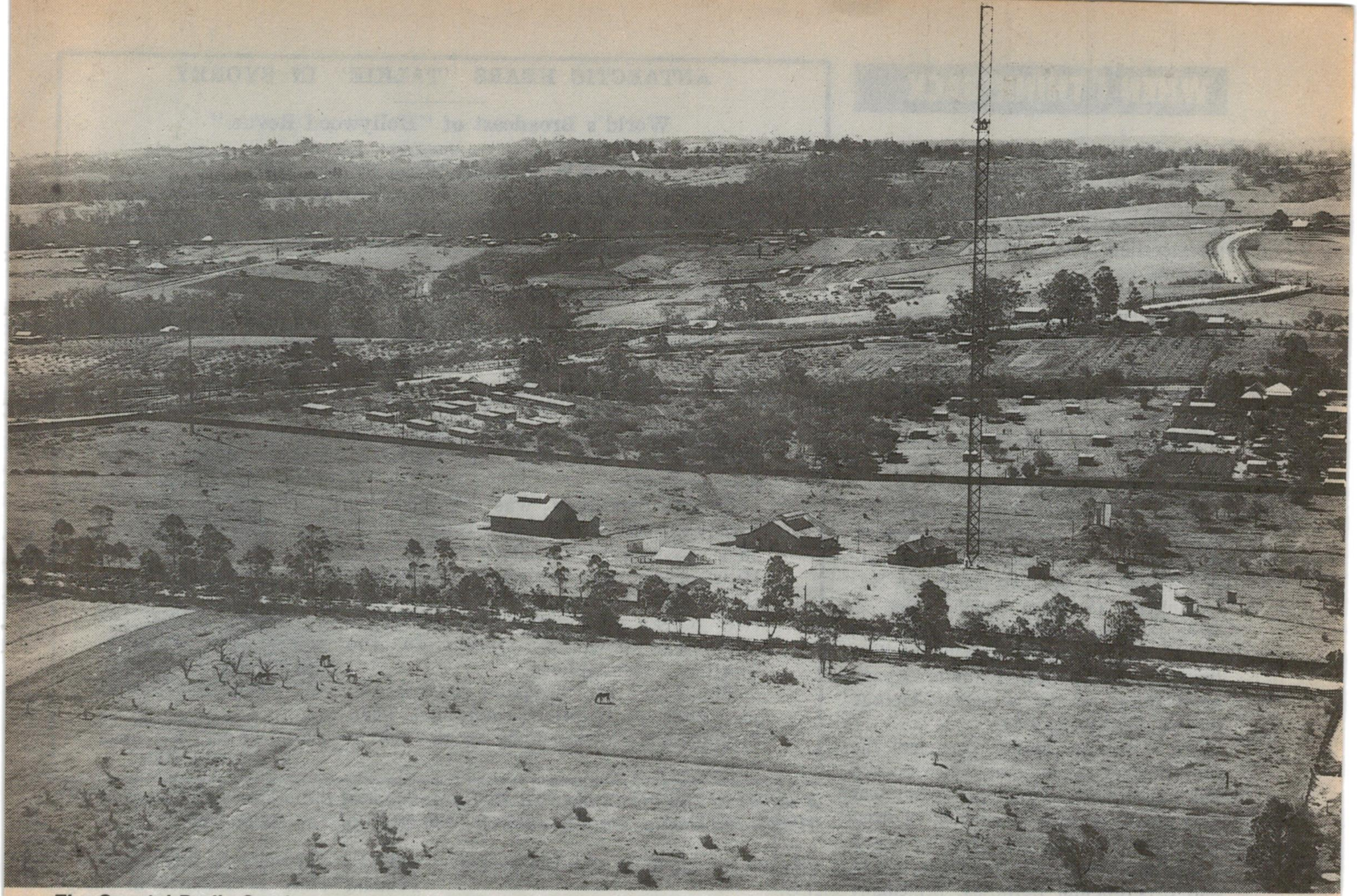
Nothing if not versatile, George Cookson was also a lay preacher, leading church services from time to time in the Cooktown area.

After the war, he stayed on with the Coastal Radio Service, which was by then in the process of reverting to civilian control. In due course, he was transferred to the main communications complex at Pennant Hills, on the northwestern fringe of Sydney, with the family taking up residence in nearby Carlingford.

In those days, the area was distinctly rural and part of the food bowl for a much smaller City of Sydney (see picture). The transmitting site was far enough west to be out of the built-up area, and sufficiently remote from the ocean to form an improbable target for any hostile warship standing off the coast.

Two large poultry farms occupied the land adjacent to the transmitting site. Dairies, orchards and market gardens were scattered around the nearby hills, while a bullock-drawn timber wagon hauled logs and sawn timber past the Cookson house to and from a nearby timber mill.

Today, I am writing this article within walking distance of this very same area, now occupied by thousands of typical red-roofed Sydney suburban cottages. Gone are the dairies, the orchards, the farms and the aerial masts which once pierced the skyline. Buses, trucks and cars jostle the roads once traversed by bullock wagons. The suburban sprawl has transformed it into just another segment of what country dwellers used to call 'the big smoke'.



The Coastal Radio Service transmitting station at Pennant Hills, around 1930. (Courtesy Len Cookson)

Beginnings

But back around 1910, a tender for the erection of a coastal service radio station at remote Pennant Hills, plus a companion station at Applecross, WA, had been accepted by the Government of the day from Father Shaw's Australian Wireless Company.

Costing 4159 pounds apiece, the stations were destined to be the most powerful in the southern hemisphere. They would use Telefunken quenched-gap spark transmitters, feeding aerials supported by a central 400ft (120m) vertical tower, and powered by a diesel engine of 60hp or more, driving a 500Hz alternator.

After sundry delays and arguments, the stations duly opened in Aug/Sept 1912. In terms of actual circuitry, the transmitters and receivers were elementary in the extreme but, with a spark gap set for breakdown at 60kV and an aerial power of around 8kW, the voltages present demanded state-of-the-art installation and maintenance. Transmissions were possible in the range 300 – 3500 metres.

In 1917, a locally produced Poulsen arc transmitter was installed at Pennant Hills, making possible telephony transmission for the first time. Valve transmitters and valve receivers made their appearance in the coastal service from about 1919. (Ref. A.S.McDonald: 'A Quarter Century of Radio Engineering in Australia', IRE Convention, 1938).

In 1922, the Federal Government acquired a majority holding in AWA and, amongst other things, commissioned the company to assume formal responsibility for the operation of the coastal radio stations (Ref: P.Geeves: *EA*, April 1989, p.47).

It was about then that George Cookson was sent to Pennant Hills as a resident engineer. Apart from normal on-site maintenance, the staff at the station also built and repaired other equipment, including high-powered transmitters.

As if that wasn't enough, Len Cookson recalls that his father spent much of his spare time building and experimenting with receivers in his own workshop.

At Willoughby

From Pennant Hills, George Cookson – plus family – was transferred to Willoughby, on Sydney's inner north shore, as resident engineer for the City's new and powerful pioneer broadcast transmitter, 2FC.

Planning for the new station had been publicised in an article 'The First Big Broadcasting Station in Australasia' in the *Australasian Wireless Review* for September 1923.

Backed by the Sydney department store Farmer & Co, the studio was to be installed by AWA on the roof of their city store. The actual transmitter would have a power input of 5000 watts, compared with the 5-10 watts commonly used by privately owned experimental stations of the day. According to the article, its nominal range would be around 400-500 miles (600-800km), but the signal would most likely be heard at night right across Australia.

The station was officially opened on January 10, 1924, although transmissions had actually begun during the previous month. It was something of an exception in being allocated a channel

ANTARCTIC HEARS "TALKIE" IN SYDNEY.

World's Broadcast of "Hollywood Revue."

By A.W.A. Short-Wave Station 2ME.

A SUCCESSFUL feat in wireless broadcasting was accomplished on February 28, when the A.W.A. Overseas Short-wave Broadcasting Station 2ME broadcast, for world reception, the midnight performance of Metro-Goldwyn-Mayer's "talkie," "Hollywood Revue," from the new Roxy Theatre, Sydney.

Messages reporting satisfactory reception were received from the Antarctic; while the whaling ships "Sir James Ross Clark" and "Neilsen Alonzo" reported good reception.

Reports from San Francisco, Suva, the s.s. "Makura," which is now north of Tahiti, and from all parts of Australia, state satisfactory reception.

Mr. J. G. Cookson, in charge of the transmitter at Pennant Hills.

The transmission was effected by Amalgamated Wireless, through their 20 k.w. short-wave station at Pennant Hills, which was designed and manufactured at the company's Radio-Electric Works at Sydney, and which is the most powerful station in the Southern Hemisphere.

This is the first occasion in Australia on which a "talkie" revue has been broadcast simultaneously to the whole world.

A report of George Cookson's 2ME broadcast of the sound track from MGM's 'Hollywood Revue', from the March 1930 issue of 'The Radiogram'.

in the long-wave band, on 1100 metres (273kHz). In *Wireless Weekly* for August 13, 1926, which I happen to have on hand, all other stations listed in the program section were in the current medium-wave band.

In *Wireless Weekly* for July 29, 1927, however, 2FC's wavelength is quoted as 442 metres (678kHz) – not too far from its present 576kHz. It would have been during this interval that my own father and his country wireless cronies got to stripping turns off their plug-in honeycomb coils, following 2FC down in wavelength and up in frequency.

My correspondent, Len Cookson, recalls that 2FC's transmitter had been set up on the site of an old dairy at the corner of First Avenue and Edinburgh Rd, Willoughby (Sydney) on the edge of what is today fashionable Castlecrag. Signals were conveyed to it by landline from the studio atop Farmers department store, on the corner of George and Market Sts, Sydney.

The Cookson family occupied the other half of the building which housed the transmitter, so that his father was very much on-call in the event of trouble. At the rear of the property was a large shed which was used for testing and experimental purposes, principally by another AWA engineer, Sydney Newman, pictured in the article by Philip Geeves in *EA* for April 1989, p.48.

In conversation, Len Cookson alerted me to the fact that the same S.M. Newman had recently written a letter to the editor of *EA*, published in the July 1989 issue, and that he lived at Waitara – only a phone call away. This proved to be the case and I caught up with him one afternoon as he returned from his tri-weekly game of bowls – at the venerable age of 92!

Syd Newman told me that, following an assignment to the British Marconi Co, he had been installed at the Willoughby centre by AWA to develop local short-wave communications equipment, some of which had been used in the England/Australia tests conducted by Ernest Fisk. It was at Willoughby that he first met Len Cookson, who was responsible for the 2FC transmitter.

Yes, Syd had been one of the historic amateur broadcasters in the Melbourne area in the early 1920s. And, yes, he had delivered a lecture to the NSW Division of the WIA in December 1921, entitled 'European Signals Amplified by 20 Valves'. And thereby hangs another tale, just waiting to be told. But back to 2FC:

On Sunday nights, according to Len Cookson, a large number of people used to congregate around the 2FC station building to listen to the program, often staying there until the last bus left for the Milson's Point ferry – which was about the time the program finished, anyway! Such was the public appetite in 1924 for a different kind of entertainment.

Short-wave radio

The mid 1920s saw not only the birth of domestic broadcasting in Australia, but also the realisation that short-wave technology could provide reliable international communication by radio telephony. The commercial links which had been forged by Ernest Fisk between British Marconi and AWA proved vital to the expansion of wireless technology in this whole area.

After a period at 2FC, George Cookson was also sent to England to expand his knowledge of current trends – an assignment which was subsidised, rather ironically, by rostering him as ship's operator for both legs of the voyage. Len recalls that his father had just three crazy weeks to get his operating skills back up to commercial standards.

Back in Australia, he was re-posted to Pennant Hills as Engineer-in-Charge, re-installed in the house that had previously been the family home and once again officially on call 24 hours per day.

Meanwhile, the range of equipment at the Pennant Hills complex, and the scope of its activities was expanding progressively such that, in his lecture to the IRE World Radio Convention in 1938, AWA General Manager L.A. Hooke noted that it comprised 14 transmitters, from 500W to 10kW aerial power and covering wavelengths from 13 to 2400 metres. They fed a wide selection of aerials with CW, ICW and speech signals, as appropriate.

Among the transmitters for which George Cookson found himself responsible was AWA's locally-built 20kW 2ME – often referred to as VK2ME – ostensibly the most powerful short-wave transmitter in the Southern Hemisphere during the '20s and early '30s.

In September, 1927, 2ME transmitted an ambitious presentation on 28.5 metres, which the BBC rebroadcast throughout Britain to the delight of a huge audience across the UK. That and four similar programs, which followed during the remainder of the year, set a pattern for 'Radio Australia', even to the distinctive signature sound – the

laugh of the Australian kookaburra.

The broadcasts also anticipated by some years the BBC's own popular Empire Short-Wave Service.

George Cookson was involved in another newsworthy broadcast in March 1930. With a quite different audience in view, he arranged a transmission of the soundtrack from the then-new MGM film *Hollywood Review*. Screened at the equally new and ornate *Roxy* Spanish theatre in nearby Parramatta, it brought a touch of home to men manning Australia's Antarctic Base, and to the whaling ships *Sir James Ross Clark* and *Neilsen Alonso*. Excellent reception was reported from San Francisco, Suva and the *S.S. Makura* in the Pacific north of Tahiti.

In his letter, Len Cookson recalls that, about this time, just before the opening of the Sydney Harbour Bridge, guards were posted at the Pennant Hills complex, because of political unrest and apprehension about the intentions of the somewhat militaristic 'New Guard' movement.

NZ stations

A news clipping records that, while still engineer-in-charge of the Pennant Hills Radio Centre, George Cookson was diverted to New Zealand to supervise planning and installation of new equipment for the New Zealand broadcast stations 1YA, 2YA and 3YA. Designed and built in the AWA radioelectric works at Ashfield, Sydney, the new and more powerful equipment replaced earlier transmitters supplied by STC London in 1927.

With an aerial power of 10kW, 1YA Auckland was destined to be the most powerful broadcaster in Australasia at the time, compared with 5kW for 2YA in Wellington and 3kW for 3YA in Christchurch. New aerials and new studio equipment were also installed.

On returning to Australia, George Cookson was posted to the AWA Head Office in York St, Sydney, where he remained until the outbreak of World War II. He was then transferred to the La Perouse complex, which had been set up as the receiving centre, complementing the transmission facilities at Pennant Hills. Equipped at the time with some 30 receivers and aerial arrays covering the range 13-20,000 metres (Ref. L.A. Hooke, IRE World Radio Convention, 1938) it also had a subsequent wartime involvement with radar for the armed forces.

A respected member of the IREE, George Cookson's final assignment, prior to his retirement, was to supervise the installation of AWA equipment at the new Overseas Telecommunication Commission (OTC) HF transmission centre at Doonside, on the western fringe of Sydney. Officially opened around 1957, it marked the ultimate displacement of AWA by OTC from international telecommunications. With an array of modern HF transmitters and a forest of console-switchable beam antennas, the move rendered the Pennant Hills complex redundant.

A companion receiving centre was set up at Bringelly, on the southern outskirts of the city, supplementing the facilities at La Perouse.

At the time, the new equipment was about as far removed as it could be from the sparks and arcs, the coherers, the crystals and the Leyden jars that characterised the technology that greeted George Cookson when he first set foot in the transmitter hut at Pennant Hills back around 1920.

Ironically, the HF equipment at Doonside is now itself 'old hat', with communication satellites in space and optical fibre cables in the offing. But this does not detract from the contribution that George Cookson made to that segment of evolving technology with which he was concerned. George died in 1962.

I am indebted to another AWA ex-employee for the tribute and the truism: "We've heard a lot about the Fisks of this world who steered large oganisations to commercial success. But they'd have gone nowhere if it hadn't been for blokes like George Cookson, who kept the roadwheels turning!"

Thanks, Len, for the notes on which your father's story was based. There has to be any number of other similar stories out there waiting to be told.

MR. COOKSON BACK FROM CHRISTCHURCH.

Mr. George Cookson, of A.W.A., engineer-in-charge of Sydney Radio Centre, Pennant Hills, returned to Australia in May after spending seven months in New Zealand, where he was in charge of the installation of 3YA, the new broadcasting station and studio of the New Zealand Broadcasting Board at Christchurch. The equipment for 3YA, which has a power of 3 kilowatts in the aerial, was designed and manufactured by A.W.A. Christchurch station is now the best of the New Zealand broadcasters, and gives not only a first class service in the South Island, but is heard in the North as clearly as Wellington.

Christchurch station will soon, however, be eclipsed by Auckland, for which A.W.A. is now constructing a station delivering 10 kilowatts in the aerial.

Another clipping from the July 1934 issue of 'The Radiogram', announcing George Cookson's return from New Zealand.

More on Fleming

To change the subject rather abruptly, I have to hand a letter from Alan March of North Turramurra, NSW, who was prompted by my article in the April 1990 issue on Sir John Ambrose Fleming to look up his name in an ancient *Harmsworth Encyclopaedia*, published in 1905. He was rewarded with a few more details of his then contemporary activities:

FLEMING, John Ambrose (1849). English electrical engineer, born at Lancaster. When the Edison Electric Company was formed, he was appointed their electrical engineer and superintended the introduction of electric lighting into England. The erection of the present engineering and electrical laboratory at University College, London, was due to him and he is now regarded as one of the first living experts on electrical matters.

He has published: 'Short Lectures to Electrical Artisans' (2nd ed. 1885); 'The Alternate Current Transformer' (new ed. 1903); 'Electric Lamps and Electric Lighting' (2nd ed. 1899); 'Magnets and Electric Currents' (1898); 'Handbook for Electrical Laboratory' (1901-3); 'Waves and Ripples in Water, Air and Ether' (1902).

Alan March says that Fleming does not get a mention in the section on electro-magnetic waves, and the only detectors discussed are 'Lodge's small revolving metal wheel dipping into mercury' and Fessenden's use of the 'heating action by leading the oscillating currents through a very fine wire or a fine thread of liquid'.

The encyclopaedia's evaluation of wireless technology at the time was that 'the speed of working...is very inferior to the speed obtained with telegraph wire or cables. On this account, the method will be useful only for temporary installations, or places where cables are difficult to lay, such as the beds of

WHEN I THINK BACK

that 'For signalling between ships, or between ships and shore, the method is unique'.

Interestingly, says Alan March, the Zeeman effect and the possibility of some physiological effects in the nervous system or the eye are mentioned. One would not expect the Zeeman effect to have been widely known at the time, but perhaps the award of the Nobel prize in 1904 for the discovery may have brought it to attention. I quote:

'It would be a pity to lose sight of the early history of this fascinating and now pervasive technology. Your articles help to remind one of remarkable people and their early discoveries and I hope that you will continue to think back for many years to come'.

Thank you for your kind remarks, Alan, but whether I would ever have gotten around to the Zeeman effect is another matter. In fact, I even had to be reminded that the term had to do with the interaction of spectral rays and magnetic fields.

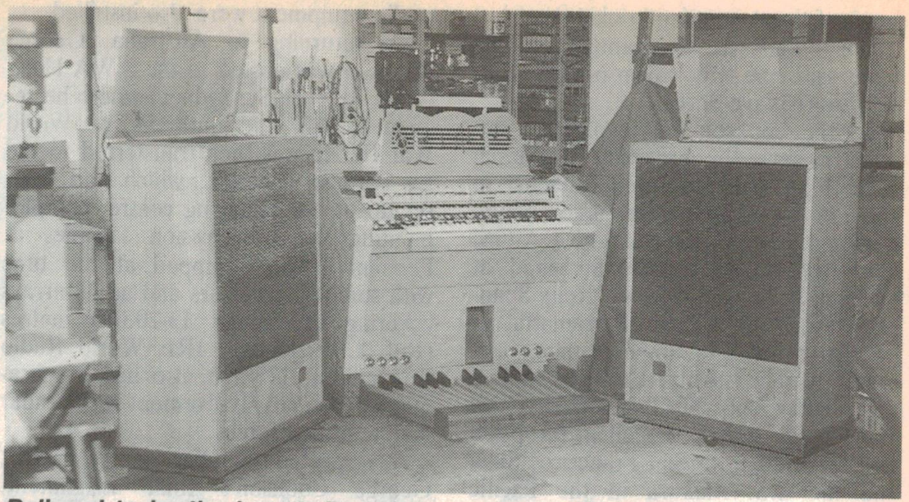
Ironically, the reminder – and the explanation – came not from a modern textbook but from an old one that I bought last year because it summarised scientific thinking around the time that I was born. Called *Scientific Ideas of Today*, it was compiled by Charles R. Gibson FRSE and published in 1916.

Very briefly, the Zeeman effect was the title given to Professor Zeeman's work in providing experimental verification of a mathematically-based theory about 'aether light' developed by another Dutch scientist H.A. Lorenz. Postulated in 1880, the theory was verified in 1896 – eight years ahead of the Nobel Award and nine years before the *Harmsworth Encyclopaedia* was published.

Bourne organs

Yet another jump in time and topic brings us to the mention of organs, electronic and otherwise, in the December 1989 issue. E.F. (Ted) Lloyd of Windways Engineering Services, in Semaphore Park, SA, writes to say that he and his wife Helen own what they believe to be the biggest organ that was completed by Alan Bourne of Newcastle, NSW.

It was specially built, he says, in 1958 for the famous 'Franquin' Magician International, forming an essential part of the show and providing musical entertainment in tours throughout Australia and New Zealand. Leading theatre organists played for what were commonly sell-out performances, including Penn Hughes, Ian Thomas, Alan Bourne himself (who played in WA) and Sydney organist Ian Davies (for the last three years of the show).



Believed to be the largest Bourne organ ever built, this instrument is being rebuilt by Mr Ted Lloyd of Semaphore Park in SA. It was originally built for the magician-hypnotist 'Franquin', in 1958.

According to Ian Davies, the organ was then sold to the illusionist The Great Levant, but was ultimately bought privately by a Lane Cove electrical engineer in the early 1970s.

He played it until the keyboard note actions finally wore out. The keyboards were removed for re-building, but a serious road accident prevented the owner from completing the task. Instead, the somewhat historic instrument was offered for sale in the NSW Theatre Organ Magazine 'as is'.

"What a mess" said Ted, when he journeyed to Sydney in a pick-up truck to buy it. The console had been stripped, in preparation for a re-polish; the new keyboards were unmounted and without contacts; the loudspeaker enclosures were in panel form and incomplete.

A visit to Alan Bourne's workshop suggested that the instrument was number 11 of the 23 built, for which they were able to obtain a few pictures and diagrams. For the rest, Ted was largely on his own.

Back home in SA, serious re-building commenced in February 1988, occupying most weekends and many evenings after work. Two years later, the instrument was nearing completion with new veneers, edge strips and trims to simulate the original finish.

The new keyboards were mounted on pivotted, folded steel channels for improved accessibility, and fitted with Kimber-Allen gold plated contacts, wiring looms and small PC boards to simplify re-connection to the original output banks. The pedal clavier was rebuilt with extra contacts for additional voices.

A complete theatre-style bench was added, plus a new music rack and a theatre-style reading light. The loudspeaker enclosures had also been rebuilt, each containing a new 100W amplifier plus four 30cm woofers facing forwards and two 20cm mid-range at the top, reflected forward by the lift-up lids.

The organ has now reached the playing stage, thanks in no small measure to the help and guidance of two friends identified only as Peter and John. It now boasts an electronic piano and harp on solo and pedal manuals and a 24V-operated 'toy counter' controlled by Wurlitzer-type toe studs in the front rail.

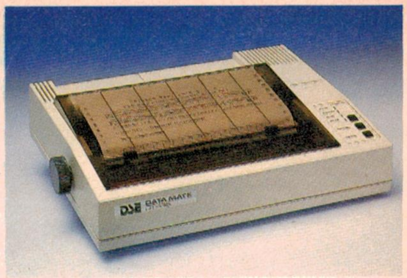
Ted's plan is to see the restored 'Bourne de Luxe' organ installed and featured as a full-scale entertainment instrument, in a suitable restaurant or winery convention area, "along with its history".

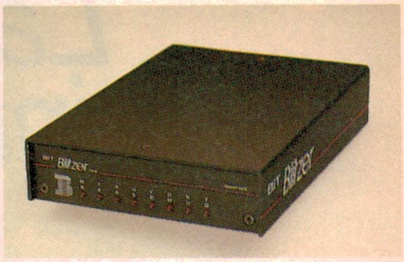
With that in view he adds: "Would any readers who have any information, copies of Franquin programs, or details of those or other existing Bourne organs please write to me". His address is:

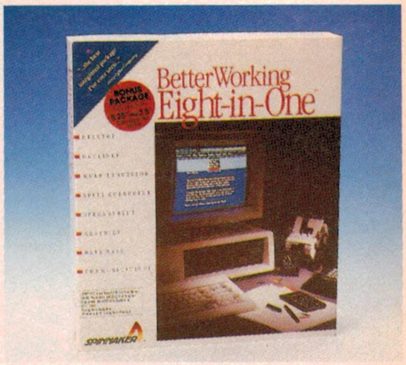
Edward F. (Ted) Lloyd,
27 Fairford Terrace,
Semaphore Park, SA 5019.

He suggests that anyone who has or knows of similar early instruments should consider obtaining and restoring them to playing condition.

"They will find it a very rewarding pleasure".







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The ACER 500+ gives you both MGA and CGA video graphics support as standard, allowing you to run both colour or graphics software on the paper-white monitor without the need for expensive add-on boards or colour monitors. It also comes fitted with both serial, parallel and games ports as standard, so that you can connect a printer and modem directly – again without any expensive adaptors. So whether you're a beginner or a serious professional user, the ACER 500+ is a great starter system.

Features include V20 processor with selectable 4.77MHz or 8MHz clock speeds; a real time clock; full 640K of memory; dual 5.25″ disk drives; 8087-2 co-processor socket; separate 84-key keyboard; MS-DOS operating system with GW-BASIC; and 12 months warranty.

The ACER 500+ system pictured above includes computer (X-8061), paper-white 30cm monitor (X-2400), 9-pin 135cps dot matrix printer (X-3225), Bit Blitzer 12E 300/300bps and 1200/1200bps communication modem (X-3306), and the Better Working Eight-in-One integrated software package (X-9402). These come complete with all interconnecting cables (X-8614, X-8007) plus a bonus box of 5.25″ diskettes (X-3501), a printer stand (X-3814) and printer paper (X-1185), to produce a full 'ready to run' system – for an amazingly low price:

ONLY $ 1995

UNBEATABLE VALUE!

The above system can be ordered from your nearest Dick Smith Electronics store or dealer, or ordered direct by phoning (008) 22 6610. Sydney callers phone 888 2105, or fax (02) 805 1986.

DICK SMITH ELECTRONICS

THAT'S RIGHT, by arrangement with Dick Smith Electronics

we have THREE of these superb ACER 500+ computer systems – each worth $1995 – to be won over the next three months by lucky *Electronics Australia with ETI* subscribers.

Each system includes ACER 500+ computer (X-8061), 30cm monitor (X-2400), 9-pin 135cps dot matrix printer (X-3225), Bit Blitzer 12E 300/300bps and 1200/1200bps communications modem (X-3306), all necessary cables, MS-DOS operating system, the 'Better Working Eight-in-One' integrated software package (X-9402), a bonus box of 5.25" DSDD diskettes, a printer stand and pack of printer paper – a package valued at $1995.

How do YOU have a chance of winning one of these superb systems? It's easy. Simply subscribe to *Electronics Australia with ETI*, or extend your current subscription for a further 12 months, between NOW and September 28, 1990. All new/renewing/extending subscriptions received during each month (July, August and September) will be registered, and one lucky subscriber from each month's group will win one of the three computer systems.

So subscribe, or renew/extend your subscription NOW!

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SAVE OVER 12%

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BONUS: EVERYONE who subscribes, renews or extends will receive absolutely FREE this economy pencil blow torch – great for heat shrink work, silver soldering, brazing, glass work, etc. It fits easily in the pocket and is powered by butane gas (the same as used in cigarette lighters, etc.). Incredibly handy and normally sells for $15.95 – but yours free!

NOT ONE, BUT THREE OF THESE SUPERB COMPUTERS TO BE WON!

BUT HURRY – THIS OFFER ENDS September 28, 1990!

To enter simply fill out the coupon attached and place it in the reply paid envelope supplied – if the coupon and the envelope are missing, send your name, address, phone number, cheque, money order or credit card details (card type, card number, expiry date and signature) to: Federal Publishing Company, Freepost No.4, P.O. Box 227, Waterloo NSW 2017. Any enquiries can be made by phoning (02) 693-6666. Unsigned orders cannot be accepted.

1. The competition is open only to Australian residents authorising a new/renewal subscription before last mail 28.09.90. Entries received after closing date will not be included. Employees of the Federal Publishing Company Pty Ltd and Dick Smith Electronics and their families are not eligible to enter. To be valid for drawing, the subscription must be signed against a nominated valid credit card or if paid by cheque, cleared for payment.

2. South Australian residents need not purchase a magazine to enter, but may enter only once by submitting their name, address and a hand-drawn facsimile of the subscription coupon to Federal Publishing Company Pty Ltd, P.O. Box 227, Waterloo NSW 2017.

3. Prizes are not transferrable or exchangeable and may not be converted to cash.

4. The judges decision is final and no correspondence will be entered into.

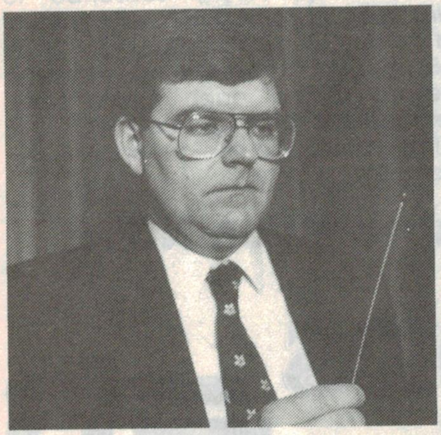
5. Description of the competition and instructions on how to enter form a part of the competition conditions.

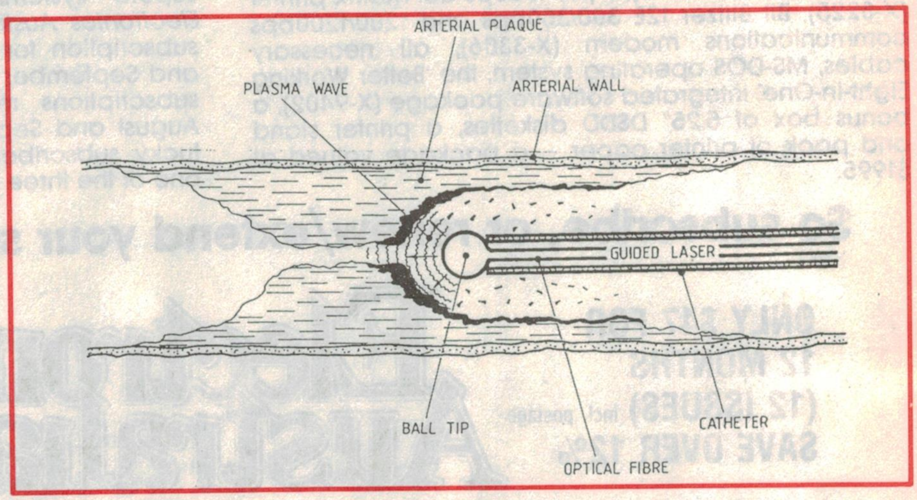
6. The competition commences on 25.06.90 and closes with last mail on 28.09.90. The draw will take place in Sydney on 03.10.90 and the winners will be notified by telephone and letter. The winners will also be announced in *The Australian* on 06.10.90 and a later issue of *Electronics Australia*.

7. The prizes are: Three Acer 500+ computer systems – each valued at $1995 – total value $5985.00.

8. The promoter is Federal Publishing Company Pty Ltd, 180 Bourke Road, Alexandria NSW 2015. Permit No. TC90/0000 issued under the Lotteries and Art Unions Act 1901; Raffles and Bingo Permit Board Permit No.90/0000 issued on 00/00/90; ACT Permit No.TP90/0000 issued under the Lotteries Ordinance, 1964.

NEWS HIGHLIGHTS





Above: Dr John Teasdale examining the ball-tipped optical catheter.

AUSTRALIAN LASER CLEARS BLOCKED ARTERIES

An Australian pulsed-laser technique capable of clearing difficult blockages in arteries without major surgery, is being used in Australia for the first time.

Designed and manufactured by Australian laser specialist company Laser Dynamics Ltd (LDL) the pulsed laser, called Ablatre, is being used to clear blockages in peripheral arteries with possible treatment of coronary arteries in the near future.

Pioneered by Dr Frank Cross of Middlesex Hospital London and Perth vascular surgeon, Dr John Teasdale, the pulsed laser technique was performed on a number of patients at Perth's Hollywood Repatriation General Hospital.

According to Dr Teasdale, the advantages of the pulsed laser over previous laser angioplasty techniques include less thermal damage to the artery wall and its ability to penetrate hard plaque in the arteries.

The Ablatre laser is a pulsed Nd:YAG (Neodymium-doped Yttrium Aluminium Garnet) laser system capable of delivering streams of high energy pulses. The wavelength involved is easily transmitted through optical fibres and the solid state system is very robust and reliable.

The fibre optic delivery systems have been designed with a fused ball on the end of the fibre. This virtually eliminates problems of mechanical perforation of the artery wall. In addition, because the ball is not 'added to' the fibre, but is part of the fibre cone material, the energy transmission to the arterial plaque is superior to other delivery systems.

The laser pulses produce a high energy plasma at the surface of the fibre ball. This causes non-thermal destruction of the plaque in the artery, with the advantages associated with 'cold' laser treatments.

NEW CSIRO LASER CENTRE

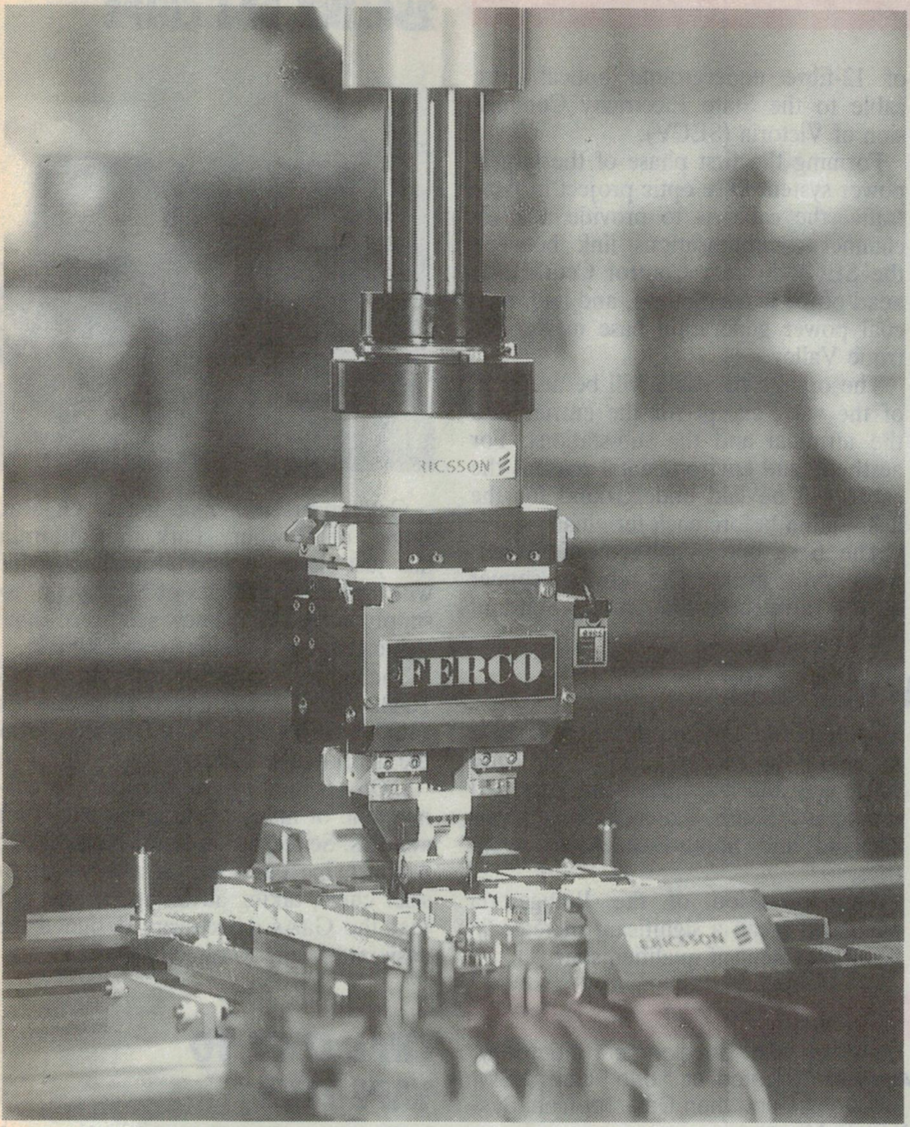
CSIRO Division of Manufacturing Technology has established an Industrial Laser Centre in Sydney to further promote the adoption of laser technology for materials processing by Australian industry. The Division recognises that industrial laser processing is an important manufacturing technology which will play a major role in strengthening the competitive position of Australian industry in the future.

Dr Milan Brandt, the manager of the Centre, said that while there are many Centres of this kind overseas, this is the first for Australia and it will play a key role in providing the necessary support for industrial laser applications in Australia. "The Centre will enable progressive Australian companies to fully evaluate the widespread capabilities of laser processing technology and to keep abreast of their competitors", said Dr Brandt.

The facilities of the Centre include a 50W average power Nd:YAG laser and a 200W continuous wave CO_2 laser and ancilliary CNC equipment. The Centre has also recently acquired a state-of-the-art high average power (500W) Nd:YAG laser combined with a three-axes fully integrated CNC system. In the near future the Centre is planning to acquire a high-power CO_2 laser for processing a range of materials at high speeds. To evaluate the effects different laser processes and parameters have on materials the Centre has access to a wide range of metallurgical testing equipment.

Designed for use in clubs, this compact new EFTPOS cash dispenser from Sydney-based EFTech uses the Philips P6616 compact cash dispenser.

PM UNVEILS ROBOT PRODUCTION PLANT



Ericsson Australia's multi-million dollar sophisticated robot production facility in Victoria has been opened by the Prime Minister, The Hon. R.J.L. Hawke, AC, MP.

Mr Hawke unveiled a placque and activated the computers which control the $8-million Robotic Cell for the new Automated Electronics Production Plant for public telephone exchange equipment, at Ericsson's Broadmeadows headquarters. The Robotic Cell is part of a $66 million capital expansion program being undertaken by Ericsson Australia to develop its international status as a world leader in telecommunications.

Ericsson Australia produces $500 million worth of telecommunications equipment per year for Australian and world markets and is the supplier of AXE digital telephone exchange equipment for the nation's public and mobile telephone systems.

The Robotic Cell consists of four independent, computer-linked robots capable of assembling and testing printed circuit boards (PCBs) for AXE telecommunications equipment.

The cell provides for flexible production of a wide variety of different PCBs from a catalogue of components and parts. It performs tests as specified by designers and manufacturing engineers and continually enhances its own 'knowledge base'. Therefore, not only is it a 'flexible' manufacturing facility, but a complete 'expert or learning machine'.

In operation, the Robotic Cell's laser scanner reads bar codes which alert the controlling computer to the identity of the next board. The computer then instructs the robot arms to insert the correct components for that board. Sensors in the robot's arm allows accurate placement of components.

PACKAGE TRIP TO TAIWAN, H-K SHOWS

Martrad International and National Travel Australia are offering a comprehensive, cost effective travel package to allow Australians to attend this year's Taipei International Electronics Show (October 6-12) and the Hong Kong International Electronics Fair (October 12-15).

The Taiwan show is expected to have over 2000 booths covering consumer electronics, computers and peripherals, communications and telecomms, components and instruments. It will be almost certainly the largest trade show ever held in Taiwan. Similarly over 21,000 international buyers are expected to attend the Hong Kong fair, with a similar range of products.

The travel package on offer includes air fares, first-class hotel accommodation close to the trade centres, transfers, show information, pre-registrations and more. Further details from Martrad International, PO Box 870, Toowong 4066 or phone (07) 870 7124.

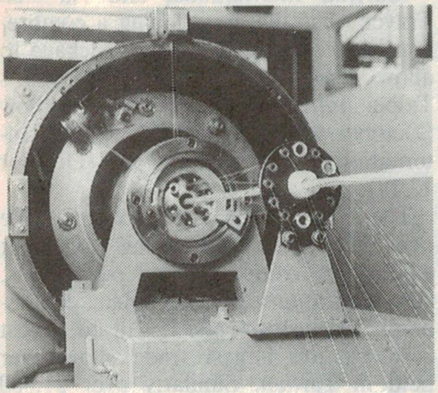
AEDC COURSES

The Australian Electronics Development Centre in Broadmeadows, Victoria, has released details of its courses for the remainder of 1990. Opened by Senator John Button in November 1989, the Centre is a non-profit organisation committed to making the Australian electronics industry internationally competitive.

Currently the Centre offers four major workshop programmes: Electronic Product Development (EPD), Printed Board Assembly Technology (PBAT), Total Quality Management (TQM) and Designing for Surface Mount (DSMT). All courses are normally conducted from 9am to 5pm on weekdays.

Remaining EPD courses for 1990 will run September 10-12, October 1-3 and October 29-31; TQM courses will run September 24-27, November 12-15 and December 3-6; PBAT courses will run September 17-21, October 15-19 and November 19-23; and DSMT courses will run September 4-5, October 22-23 and November 27-28. Fees for two-day courses are $450, with three-day course $675, four-day courses $850 and five-day courses $975; the fees include course materials and lunches.

Further details are available from AEDC, cnr Riggall and Maldon Streets, Broadmeadows 3047 or phone (03) 302 1422.



FIBRE-OPTIC LINKS FOR SECV

In a contract worth over $800,000, MM Cables has supplied 115km of 12-fibre aerial optical fibre cable and 10km of 12-fibre underground optical fibre cable to the State Electricity Commission of Victoria (SECV).

Forming the first phase of the largest power system fibre optic project in Australia, the cable is to provide a 1920-channel communications link between the SECV System Control Centre and head office in Melbourne, and its brown coal power generation base in the Latrobe Valley.

The optic fibre cable will be aerial all of the way, except for the entries into the terminal and the sub-stations. For aesthetic and environmental reasons the cable will be laid underground for the last section before each terminal.

The fibre optic communications network will eventually replace copper cables throughout the entire State of Victoria.

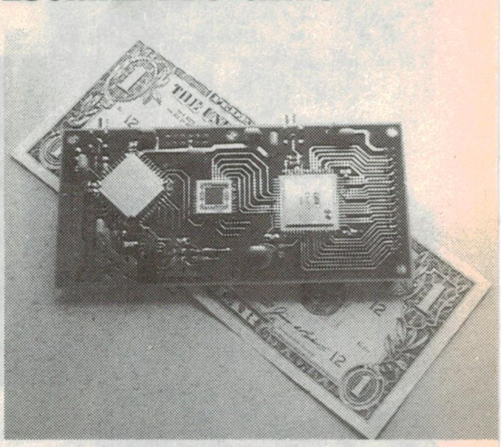
IBM EXPANDING WANGARATTA PLANT

IBM Australia has announced plans to further expand its manufacturing plant in Wangaratta, Victoria, lifting its export earnings to more than $300 million annually.

As part of the expansion the plant will be manufacturing the RISC System/6000, a family of AIX-based high performance workstations and network servers. Full production of these machines will be phased in during early 1991, with the machines being exported to Japan, South Korea, China, New Zealand and South-East Asian countries.

The expansion of the Wangaratta plant will mean a significant increase in its employment of qualified staff.

BIG ORDER FOR 250MHZ DDS CHIPS



Gallium arsenide chip maker GigaBit Logic, of Newbury Park in California has just signed a US$1.1 million order with Sciteq Electronics of San Diego, to supply direct frequency synthesis chipsets capable of outputs up to 250MHz.

The chipsets include GigaBit's 10G103 1GHz 32-bit accumulator chip and its 14G048 512 x 8-bit ROM, which form the heart of the DDS systems.

DDS technology has become the cornerstone of many new signal generation systems. Sciteq has developed its ADS-2 product line based on GigaBit's synthesiser chips, taking advantage of the fact that the GaAs devices are designed for easy interfacing to silicon DACs.

NEWS BRIEFS

- Canon Australia has established a research and development company, ***Canon Information Systems Research Australia***, located at North Ryde, NSW. Mike Wilson, previously MD of Dick Smith Electronics and then Data Terminal Systems has been appointed as Canon's NSW State Manager.
- ***Adelaide's Electronics 90*** Conference and Exhibition will be held from October 2-4, 1990 at the Regency College of TAFE. For further information contact Phillip Styles Exhibition Services, 4 Lovell Court, Clarence Gardens 5039 or phone (08) 371 1700.
- To complement its Perth operation, ***Quiptek*** has opened a Melbourne office. The address is Suite 66, Sandbelt Motel, 630/646 South Road, Moorabin 3189 or phone (03) 532 1328.
- Tony Cooper has been appointed as the Northern regional Manager for the Semiconductor Division of ***Texas Instruments***.
- US Company VLSI Technology has appointed the ***George Brown Group*** to represent it in the Australian and New Zealand market places.
- Mr Aiji Harada has been appointed as the new Managing Director of ***NEC Australia***. He was the Senior Vice President of NEC America and is an acknowledged authority on microwave communication systems and Japanese-American business/technology relations.
- ***Crusader Electronic Components*** has been appointed the agent for three more companies: BKC International Electronics of USA, maker of germanium and silicon diodes; Fenwal Electronics of USA, thermistor product manufacturer; and Arcotronics of Italy for its power capacitors. The address is 73-81 Princes Highway, St Peters 2044.
- Italian broadcast antenna manufacturer Sistemi Radio (SIRA) has appointed ***Vicom Group*** of 4 Meaden Street, South Melbourne 3205 as its Australian representative.

CHALLENGE TO TAPE LEVY

The Australian Tape Manufacturers' Association has issued a High Court Writ, which claims that the provisions of the 1989 Copyright Amendment Act introducing a scheme for imposing a royalty on blank audio cassettes are unconstitutional. According to ATMA's secretary Ian Prosser, his organisation took the step after receiving legal advice that the scheme was beyond the legislative power of the Commonwealth Parliament, and is not supported by Section 51 of the Constitution.

Although the amount of the levy has not yet been fixed, the ATMA also claims that it will be both an unreasonable and unnecessary impost on the consumer. Unreasonable because of the way wholesale levies almost double by the time they are passed on to the consumer, and unnecessary because the ATMA says there are alternatives to royalty schemes, which do not require legislation.

RAMTRON & NMBS FORM JOINT COMPANY

In a move that further establishes Ramtron as a major force in the development of advanced semiconductor memory devices, Ramtron Australia has announced a broad expansion of its US subsidiary's strategic alliance with NMB Semiconductors of Japan.

Ramtron Corporation and NMBS have jointly formed a separate company to design and develop advanced generations of high-speed DRAMs with densities of 16-megabits and above, as well as other speciality memory products for use in a new generation of advanced personal computers, workstations and digital television. The joint venture company's design group is the same team that designed the world's first 40 nanosecond 4-megabit CMOS DRAM.

The new venture, which began operations on July 1 will service as a research, design and development resource for both Ramtron and NMBS. The President of the new company is Sheffield Eaton, former DRAM Design Manager of Ramtron Corporation. The Chairman of the Board is Shosuke Sinoda, also Executive Vice President of NMBS.

JAPAN EXPANDS IMPORT PROGRAMS

Japan has introduced comprehensive new measures to encourage imports, and according to Mr Yashuhiro Tashiro the managing director of Japan's External Trade Organisation (JETRO) Sydney office, this offers an excellent opportunity for Australian exporters to target the lucrative Japanese market.

The new import expansion program is apparently designed to mirror previous export-oriented programs. It includes elimination of import tariffs on a further 1004 manufactured items, and reduction of tariffs on others. Almost all machinery can now enter Japan duty free.

Other measures include tax incentives for Japanese manufacturers who lift their levels of qualified imports, an increased budget for promotion of imported goods (to A$130 million), and expansion of the low interest rate loan program to encourage importing – including loans to overseas companies.

Further details of the new program are available from JETRO, which can also offer information, advice and practical assistance to firms interested in importing to Japan. Contact JETRO, Level 19, Gateway, 1 Macquarie Place, Sydney 2000 or phone (02) 241 1181.

A parallel processor chip claimed to be the world's largest is shown here under test at Brunel University in West London. Developed by Professor Mike Lea and his team, the chip uses wafer-scale integration. It measures 97.5 x 91mm, and contains 6480 parallel processors (8.43 million transistors).

AUSTEK DEVELOPS CHIP FOR DESKTOP SUPERCOMPUTERS

An Australian designed processor using custom-designed integrated circuits is expected to give personal desktop workstations performance approaching that of today's supercomputers.

The processor, called the Systolic Configurable Array Processor (scap) is being designed for the Australian Department of Defence by Adelaide-based Austek Microsystems. The SCAP is expected to give Sun's SPARCstation workstations peak speeds of 200 million floating point operations per second (200 megaflops).

Instead of a single processing chip, the SCAP processor will attack a mathematical problem with an array of processors, called 'processing elements'. Instead of dealing with single vectors sequentially, it performs calculations on systems of vectors, or matrices, simultaneously.

Conceived by Defence Department mathematician Pat Clarke and engineer Warren Marwood, the SCAP is based on theories they have developed on chip stacking, which allow processing power to be incrementally added to a processing array.

Clarke explained, "very complex scientific calculations require immense computing power. The implications of chip stacking are that supercomputers can be further miniaturised. Calculations for weather forecasting and aerodynamic analysis could be done with a desktop workstation, rather than a supercomputer."

As part of the $1.2 million contract, Austek will design an array of 256 processing elements, implements as a custom array of stacked processors. Austek will also develop data controller chips to handle data flow into and out of the processing element array.

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THE XITEL XM-12E MODEM

The XM-12E is designed for applications that require high speed, full duplex data communications such as data base access, file transfer and electronic mail (e.g. Austpac and Keylink) as well as direct communications and other CCITT and Bell systems.

KEY FEATURES:
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- Fits over keyboard

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- Includes pull-out shelf for Mouse
- Dimensions: 280 x 260 x 25mm
- Fits over keyboard

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- Suitable for most printers
- Excellent value at this price
- 80 COLUMN

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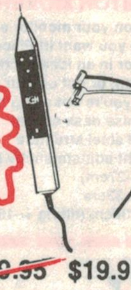

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DC CURRENT: 0- 10A
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AC CURRENT: 0- 10A
RESISTANCE: 0- 20M OHMS
COMPACITANCE: 0- 20u[
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DC VOLTAGE: 0- 1000V
DC CURRENT: 0- 20A
AC VOLTAGE: 0- 750V
AC CURRENT: 0- 20A
RESISTANCE: 0- 20M OHMS
TEMPERATURE: - 20C- 1200C
CONTINUITY TEST, DIODE TEST
TEMPERATURE, CAPACITANCE
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SAVE $30

DISPLAY: 3 1/2 DIGIT
DC VOLTAGE: 0- 1000V
DC CURRENT: 0- 10A
AC VOLTAGE: 0- 750V
AC CURRENT: 0- 10A
RESISTANCE: 0- 20M OHMS
CONTINUITY TEST, DIODE TEST,
DATA HOLD, TR HFE GAIN,
AUTO RANGE DMM WITH BAR GRAPH.
Q13040...............RRP ~~$99.95~~ $69.95

ANALOGUE/DIGITAL MULTI METER

SAVE $60

HC- 5050DB 3 1/2 DIGIT
BASIC ACCURACY: 0.5% DC
DC VOLTAGE: 0- 1000V
DC CURRENT: 0- 10A
AC VOLTAGE: 0- 750V
AC CURRENT: 0- 10A
RESISTANCE: 0- 20M OHMS
DC AC RMS: -45dB -+50dB
TEMPERATURE: - 20C- 1200C
AC FREQ SPREAD: 50Hz -2KHz
CONTINUITY TEST, DIODE TEST
Q13020..........................RRP ~~$169.95~~ $109.95

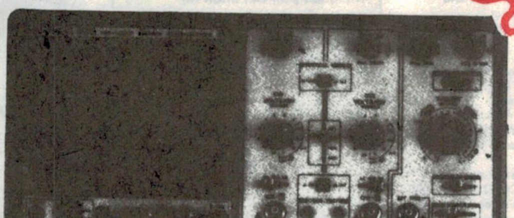
DIGITAL MULTI METER HC- 4510

SAVE $50

DISPLAY: 4 1/2 DIGIT
BASIC ACCURACY: 0.5% DC V
DC VOLTAGE: 0- 1000V
DC CURRENT: 0- 10A
AC VOLTAGE: 0- 750V
AC CURRENT: 0- 10A
RESISTANCE: 0- 20M OHMS
CONTINUITY TEST, DIODE TEST,
DATA HOLD.
Q13030..........................RRP ~~$149.95~~ $99.95

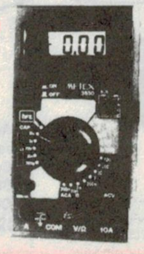
20 MHz DUAL TRACE MODEL 0S - 620

SAVE $55



CRT: 150MM RECTANGULAR
DC: DC TO 20MHz
AC: AC TO 20MHz
CH1, CH2, ADD, DUAL, AUTO AND NORM
TRIGGERED POSITIVE AND NEGATIVE
CONTINUOUSLY VARIABLE.
Q12105..........................RRP ~~$750~~ $695

DIGITAL MULTI METER 3530



SAVE $60

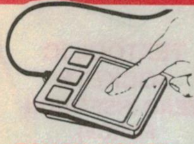
3 1/2 DIGIT 10 AMP
DC VOLTAGE: 0- 1000V
DC CURRENT: 0- 10A
AC VOLTAGE: 0- 700V
AC CURRENT: 0- 10A
RESISTANCE: 0- 20M OHMS
CONTINUITY TEST, DIODE TEST
Q91540..........................RRP ~~$149.95~~ $89.95

008 335757 TOLL FREE MAIL ORDER HOTLINE FOR CREDIT CARD ORDERS! LOCAL ORDERS AND INQUIRIES CALL (03) 543 7877.

GREAT SAVINGS GREAT SAVINGS GREAT SAVINGS

IT'S NEW

ROD IRVING ELECTRONICS



TOUCH MOUSE

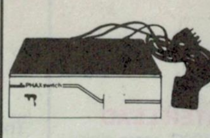
A STATIONARY BREAK THROUGH !!!

Now you can use your fingers instead of your mouse.

MODELS: ATM- 110 Touch Mouse for IBM PC/ XT/ AT and compatible's, Operates under Microsoft / mouse system mode.

FEATURES:
· User's finger movements on the 58 X 48mm front panel of the touch mouse control the on-screen cursor movement.
· With no ball, the touch mouse requires no desk space for movement.
· No pad to get dirty and take up desk space.
· One finger can do all the users drawing.
· Compatible with all existing mouse software.
· RS- 232 serial port
- Especially suitable for laptops, the touch mouse saves on desk space.

X19960.................$149.00

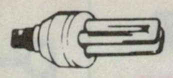


FAX SWITCH

·Lets you connect a normal telephone hand set and a fax to the same telephone line
· Detects whether an incoming call is for the fax or for the phone and automatically switches it through to the correct unit.
· It also automatically switches when you pick up the phone or use the fax machine to make an out going call or fax.
· Lets you overide the automatic switching and connect the line to either the phone or the fax as you wish.
· It is protected against lightning strikes- your Fax Switch has built in protection against power surges, created by lightning striking telephone lines.

X19090........................$289

SAVE ENERGY SAVE YOUR PLANET !



S14049 7W BC...$34.95
S14051 11W BC..$34.95
S14052 15W BC..$34.45

S14053 12W BC..$42.95
S14054 18W BC..$44.95

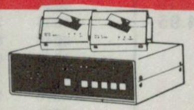
Why not save money by cutting your energy costs down by 80% ?
Each Fluro globe produces 5 times the light to the normal globe. So theres no need to buy 100 watt globes when you can by 20 watt globes to replace 100 watt globes.
Save money by using power at only 20% of the previous rate.
These Fluro globes last at least 8 times as long as the normal globe.

ROD IRVING ELECTRONICS LOOKING TO THE FUTURE !

AIR IONS GENERATOR

No need for air freshners with our Negative Air Ions Generator.
Just plug it into the cars cigarette lighter and it releases negative air ions into the vehicle....making a fresh driving environment.
Odors , smoke and dust are eliminated and a fresh feeling prevails. The product is also good for the respiratory and blood systems.

A15072.....................$39.95

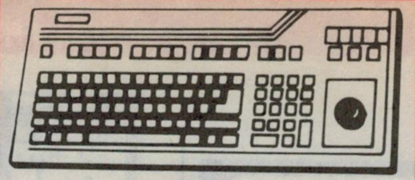


"PRINTER BUFFER" PB - 42P PRINTER BUFFER

The printer buffer is for offices or schools which have high volume data to process. Its a time saver. It accepts data from your computer and stores the data in its memory, then feeds the data to your printer at its own speed so that your computer is free for other work.

256K FITTED CAN TAKE UP TO 1 MEG OF RAM.

X19160.......................$595



101 KEY TRACKBALL KEYBOARD

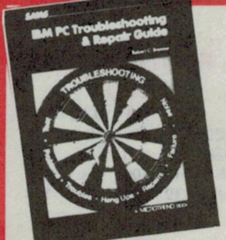
The Trackball keyboard is a palm driven mouse which is built into your NEW keyboard. Above the ball is 3 keys- which allow you your selections and zooming in and out on work.
The Trackball allows you to keep the feel of your work right in the centre of your palm.

Advantages of the Trackball mouse:
· It is more accurate than other cursor controls
· It has more flexibility than other devices.
· It is so responsive that you can move your cursor across the sceen in a split second and continue working in another area.
· Distortion free drawing ability.
· Compadability with other major mouse systems
· Dynamic resolution.

Specifications:
·Microsoft serial mouse and PC mouse compatible
·Tracking speed- 900mm/sec.
· Resolution- 200 dpi (dots per ")
  Dynamic resolution- 100-1200 dpi
· Opto mechanical encoder.

X12030...$169.95

FREE CATALOGUE WITH EACH ORDER

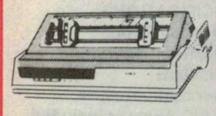


IBM PC TROUBLESHOOTING & REPAIR GUIDE

- By Robert .C. Brenner.
Keep your IBM PC in top operating condition with this handy reference manual.
Inside you will find pages of schematics, photos and block diagrams to help you identify problems.
Simple instructions tell you whats wrong and how to FIX it.

B20115..............$49.95

$$$ SUPER SAVINGS $$$

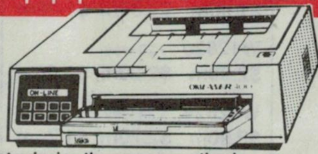


AUSTRALIA'S CHEAPEST PRINTER MICROLINE 172

* Compact, reliable economical. This OKI dot matrix printer is a great investment for the office or home. The Microline 172 fits anywhere you need it, and OKI's exclusive bottom line feed helps improve your workflow.
* 180 CPS printer
* NLQ30 CPS

YOU WONT FIND IT CHEAPER!

ONLY.........$249



OKILASER PRINTER ONLY...$1,995 (inc. tax)

Introducing the new generation in page printers, the OKILASER 400.
The affordable LED page printer designed for the small business.
Reliable and compact, the OKILASER 400 fits neatlt into the smallest of offices.
Highly reliable due to the latest LED imaging technology, the OKILASER 400 offers excellent print quality, superior paper handling, and a variety of fonts which revival some of the more expensive laser printer on the market.

SPECIFICATIONS OL400:
Printing speed: 4 pages p.m
Resolution: 300 x 300 DPI
Emulation: HP laserjet series II
Data Buffer: 512K byte (standard)
  1 M/B expansion (option)
  2 M/B expansion (option)
  Max. 2.5M/B
Interface: Centronics Parallel or RS232 Serial
Resident fonts: 25 various
Standard paper input: 200 sheets
Standard paper output: 200 sheets face up
  100 sheets

ENCLOSED PRINTER STAND

· Transparent cover makes it easy to check on paper supply.
· Paper can be fed from the centre or the rear according to the design of the printer.
· Removable drawer wich allows paper to be changed without moving the printer.
· Retractable rear basket makes print out collection fast and convenient.
· Suitable for most printers

C21055......................$29.95

HIGH PERFORMACE, LOW PRICE

24 PIN MICROLINE 380

The Microline 380 is the perfect letter quality printer. Ideal for the small business or home.
It's size allows it to fit on the smallest desk in the smallest of offices. The microline 380 is a 24 pin dot matrix which is fast and reliable with a MTBF of 4000 hours and a printhead life of 12000 hours. Combine this with the high quailty of print and you've got a printer that will work with you for many years to come.

SPECIFICATIONS:

Technology,	Speed and Print Characteristics.
Print Method:	24-pin (20 mm diameter) Imapct Dot Matrix
Graphics Resolution:	60 x 72 dpi minimum 180 x 360 dpi maximum
Feed rate :	2.2 lps
Character Sets:	Standard ASCII Epson Charater Set IBM Set I and II Foreign Language sets Zero/Stashed Zero
Vertical Line Spacing:	Fixed 6 lpi, 8 lpi — Varaible n/60", n/180"
Print Direction:	Bidirectional, short line seeking

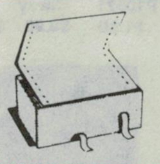
Letter Quality: 60 CPS 30 x 18 @ 12 cpi
Utility: 180 CPS 9 x 17 @ 12 cpi

Print features:
3 L Q Resident Fonts
  Emphasized Enhanced
Italics
  Double height Double Width
Continuous Underlining
  Super/Subscipt Outline/Shadow

Reliablity:
MTBF:4000 hours (25% duty cycle 35% page density)
MTTR: 15 minutes
Printhead life: 12000 hours (25% duty cycle 35% page density)
Printhead Life : 200,000,000 characters avg in 10 cpi draft mode @ normal 25% duty 35% page density (user replacable)
Net weight: 7.7 kg (17lbs)
Power consumtion: Operating 86 VA, Idle 22 VA
Size : 15.7" (w) x 13.6" (d) x 4.7 (h)
  [39.8cm (w) x 34.5 cm (d) x 12.0 cm(h)

....$545

PRINTER PAPER



COMPUTER PAPER

Quality paper at a low price !
2,000 sheets of 60 gsm bond paper.

· 11 x 9 1/2"
C21001.............$41.00
· 15 x 11"
C210[illegible]1.............$59.95

MAGIC EYES

These glasses are great for cheching circut boards, inside dark places, repairing or observing. There's no need to take your glasses off because they fit neatly over.

A15062...................$19.95

rie

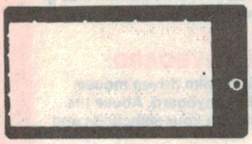
ROD IRVING ELECTRONICS

Please quote this advertisement for the prices listed for this month.
SYDNEY: 74 Parramatta Rd. Stanmore.2048
Phone: (02) 519 3134
Fax: (02) 519 3868
MELBOURNE: 48 A'Beckett St
Phone: (03) 663 6151
NORTHCOTE: 425 High St.
Phone: (03) 489 8866
MAIL ORDER & CORRESPONDENCE:
P.O. Box 620, CLAYTON 3168
Order Hotline: 008 33 5757
(Toll free, strictly orders only)
Inquiries: (03) 543 7877
Telex: AA 151938
Fax: (03) 543 2648
All sales tax exempt orders and wholesale inquiries to:
RITRONICS WHOLESALE -
56 Renver Road, Clayton.
Phone:(03) 543 2166
Fax: (03) 543 2648

BARGAINS BARGAINS BARGAINS BARGAINS BARGAINS

088 335757 TOLL FREE MAIL ORDER HOTLINE FOR CREDIT CARD ORDERS!

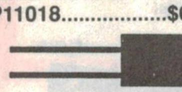
ROD IRVING ELECTRONICS



BREAD BOARDS

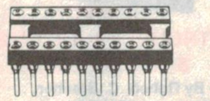
This inexpensive rang of modular interlocking units enables a quick, easy way of experimenting with new circuits and ideas. There are two main units consisting of a terminal strip or distribution and a Central plug-in unit.

- 100 holes
P11000..................$2.75
- 640 + 100 holes
P11007.................$14.95
- 1280 + 100 holes
P11010.................$26.95
- 2560 + 700 holes
P11018.................$69.95



RECTANGULAR LEDS

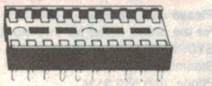
	1-9	10-99	100+
RED	20c	15c	12c
GREEN	20c	15c	12c
YELLOW	20c	15c	12c
ORANGE	20c	15c	12c



GOLD INSERT LOW PROFILE IC SOCKETS

- Gold machined pins
- Extremely high quality
- Anti-wicking
- Ideal for professional use or where field service components is required.

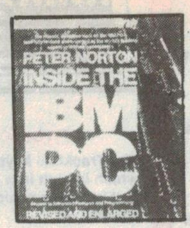
Cat.no.	Description	1-9	10+
P10620	8 pin	$1.20	$1.10
P10624	14 pin	$1.60	$1.40
P10626	16 pin	$1.90	$1.80
P10628	18 pin	$2.00	$1.90
P10630	20 pin	$2.20	$2.00
P10632	22 pin	$2.40	$2.20
P10634	24 pin	$2.60	$2.40
P10640	28 pin	$2.90	$2.70
P10644	40 pin	$2.95	$2.75



LOW PROFILE IC SOCKETS

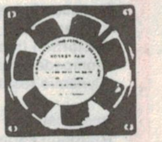
Save a small fortune on these "Direct Import" low profile Ic sockets! PCB mounting solder tail. All tin plated phosphor bronze or beryllium and dual wipe for reliability.

Cat. No.	Description	1-9	10+
P10550	8 pin	$0.20	$0.18
P10560	14 pin	$0.25	$0.20
P10565	16 pin	$0.25	$0.20
P10567	18 pin	$0.40	$0.35
P10568	20 pin	$0.40	$0.35
P10569	22 pin	$0.40	$0.30
P10570	24 pin	$0.40	$0.30
P10572	28 pin	$0.50	$0.40
P10575	40 pin	$0.50	$0.40



INSIDE THE IBM PC

(Revised and expanded edition)
-Peter Norton
The widely acclaimed guide to the IBM PC's inner workings. The latest edition now covers every model of the IBM micro, PC, XT and AT, and every version of DOS from 1.1 to 3.0
B20080 .... $44.95



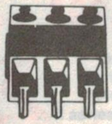
12V DC FANS

80 x 80 x 25.4mm
12V DC, 1.7 Watt, 0.14 Amps
T12469.................$12.95
10+ fans only $11.95 each

BALL BEARING FANS

Quality, fans for use in power amps, computers, hotspot cooling etc. Anywhere you need plenty of air.

240V 4 5/8" T12461...$14.95
115V 4 5/8" T12463...$14.95
240V 3 1/2" T12465...$14.95
115V 3 1/2" T12467...$14.95
10+ fans (mixed) only $13.95 each

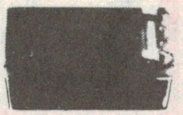


PCB MOUNTING SCREW TERMINALS

(INTERLOCKING ENDS)

These terminals feature interlocking ends to form any number of conections. Standard 5mm spacing pins

		1-9	10+	100+
P10520	2 way	$0.75	$0.70	$0.60
P10521	3way	$1.00	$0.90	$0.80



RECHARGEABLE 12V GELL BATTERIES

Leakproof and in 3 convenient sizes, these long service life batteries are ideal for burgular systems, emergency lighting or as a computer backup power supply ideal for many power supply ideal for many power needs.

Cat S15029 12V 1 2 AH
.............................$29.95
Cat S15031 12V 2 6 AH
.............................$39.50
Cat S15033 12V 4 5 AH
.............................$49.50

THIS MONTHS INCREDIBLE IC'S SPECIALS

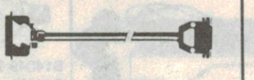
	1-9	10 +
4002	29c	25c
4007	20c	18c
4012	20c	18c
4014	75c	70c
4018	75c	65c
4022	35c	30c
4034	1.30	1.10
4035	75c	60c
4040	60c	50c
4047	65c	60c
4071	25c	20c
4075	25c	20c
4081	25c	22c
4098	60c	50c
4510	70c	60c
4511	75c	70c
4515	80c	70c
4516	80c	70c
4518	75c	70c
4520	75c	70c
4526	80c	70c
4536	2.50	2.00
4556	50c	40c
MM5369	2.50	2.20
40175	50c	40c
7402	50c	40c
7405	50c	40c
7409	40c	35c
7410	45c	40c
7425	50c	40c
7426	30c	25c
7427	50c	40c
7430	50c	40c
7437	60c	55c
7438	30c	25c
7446	50c	45c
7447	50c	45c
7473	60c	55c
7475	60c	55c
7476	60c	55c
7493	50c	45c
7495	65c	60c
7497	1.20	1.00
74125	60c	55c
74126	60c	55c
74145	75c	70c
74150	1.00	90c
74155	60c	55c
74157	60c	55c
74161	60c	55c
74164	60c	55c
74174	60c	55c
74175	50c	45c
74283	75c	70c
74290	50c	45c
74f00	30c	25c
74F32	30c	25c
74F109	42c	35c
74F153	25c	20c
74F157	80c	70c
74F181	2.50	2.20
74F194	1.00	80c

OFFER VALID TILL JULY 30, 1990

CRYSTALS

1/2 PRICE OFF ALL CRYSTALS

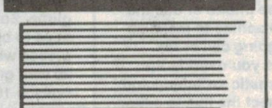
Y11000	1MHz	$11.50
Y11003	1.8432MHz	$7.50
Y11005	2MHz	$6.90
Y11007	2.3040 MHz	$6.50
Y11008	2.4576 MHz	$6.50
Y11009	2.7648 MHz	[illegible].90
Y11010	3MHz	[illegible]90
Y11015	3.5795[illegible]	[illegible]00
Y11018	3.9[illegible]	[illegible]
Y11020	[illegible]	[illegible].90
Y11022	[illegible]z	$3.90
Y11023	[illegible]MHz	$4.90
Y110[illegible]	[illegible] MHz	$4.90
Y11[illegible]	[illegible].75 MHz	$4.90
Y110[illegible]	4.9152 MHz	$6.90
Y110[illegible]	4.9562 MHz	$4.90
Y11030	5MHz	$4.90
Y11033	5.0688MHz	$4.90
Y11042	6.144 MHz	$4.90
Y11050	8.00 MHz	$4.90
Y11055	8.86723MHz	$4.90
Y11070	12.00 MHz	$4.90
Y11072	14.318 MHz	$4.90
Y11080	16.00 MHz	$4.90
Y11085	18.432 MHz	$4.90
Y11090	20.00 MHz	$4.90



PRINTER LEAD

- Suits IBM* PC/XT, compatibles
- 25 pin "D" plug (computer end) to Centronics 36 pin plug
- 1.8 metres
P19029...................$14.95
- 3 metres
P19030...................$19.95
- 10 metres
P19034...................$39.95

CABLES



FLAT GREY RIBBON CABLE

- Flat cable for IDC connectors
- m = metre

		1-9m.	10+m.	100+m.
W12614	14 way	$1.90m	$1.80m	$1.20m
W12616	16 way	$1.90m	$1.80m	$1.20m
W12620	20 way	$2.50m	$2.20m	$1.50m
W12624	24 way	$2.90m	$2.70m	$1.70m
W12626	26 way	$3.60m	$3.30m	$2.20m
W12634	34 way	$3.90m	$3.60m	$2.30m
W12636	36 way	$1.90m	$1.80m	$1.20m
W12640	40 way	$4.90m	$4.00m	$2.80m
W12650	50 way	$5.50m	$4.90m	$2.90m

COMPUTER CABLE

- Six conductor shielded computer interface cable
- m = metre

		1-9 m	10+ m	100+ m
W12670	CIC6	$1.30m	$1.10m	$1.00m
W12672	CIC9	$1.60m	$1.50m	$1.20m
W12674	CIC12	$2.50m	$2.20m	$1.90m
W12676	CIC16	$3.50m	$3.20m	$2.50m
W12678	CIC25	$3.90m	$3.40m	$3.00m

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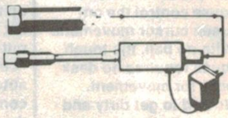

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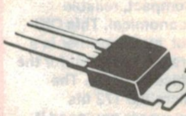

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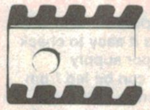

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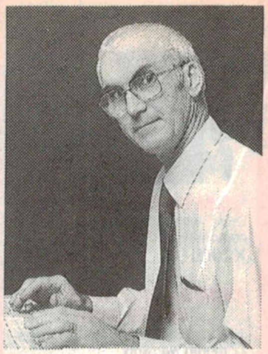
FORUM

Conducted by Jim Rowe



Mr Cardas explains his cables, and though confused, I eat humble pie

No doubt some of you are getting a little tired of audio cables as a subject – although judging from the letters that have come in lately, it does seem that many find them an interesting topic. There's a particularly interesting one from Mr George Cardas, whose expensive multi-diameter stranded cables were discussed somewhat skeptically in the May issue...

After my criticism of his cables in the May issue, I can hardly deny Mr Cardas the right to reply. In any case, it's nice to get a reply directly from an overseas designer/manufacturer; usually there's either no response at all, or at most a call from the local distributor. Getting a reply direct from the designer himself is both flattering and constructive, because it cuts out any possible misinterpretation by intermediaries.

I'm proposing to reprint Mr Cardas' letter in full, but before I do there's another small matter which should be cleared up. (I sound a bit like a TV current-affairs show presenter, don't I – tease you up front with a glimpse of the main story, then say "But first, we look at..." Sorry about that – don't tell Stuart Littlemore!)

The fact is that I goofed, in the June column discussing toroidal transformer operation. Since the issue came out, I've had a number of letters from astute readers pointing out that I was wrong in saying that such a transformer's mounting bolt constitutes a half-turn secondary. In fact it's effectively a *full* turn, because the turn is completed by any circuit that you hook up to it, to measure or make use of the induced voltage.

My face is a suitable shade of crimson, folks, and thanks to those who spotted the mistake and hastened to let me know.

Mr Charles Borger, an engineering consultant of Pascoe Vale in Victoria, pointed out that the only way to obtain a half-turn in a toroidal transformer is to have a turn which passes out through a hole, drilled in the core either halfway out radially, or half-way up axially. But he also added that I shouldn't feel too guilty about making the mistake, as he's found the assumption to be a very common one.

Another letter came from Mr John Innes, of Cremorne in NSW, who took me to task in such an entertaining way that it was impossible to be upset. His letter was a bit too long to reproduce in full, but here are a couple of snippets:

If you draw out the full measuring circuit, you will see that your secondary circuit is one full turn around the core, and the voltage across the meter is equal to the sum of the EMF's around the loop, external to the meter – Kirchoff says so. By all means doubt what I say; go and wind three, four or five turns, whatever way you count them, on the toroid and measure the result. But please phone me first, because I want to place a small wager that you will get three, four or five times what you measured on your 'half turn'...

...It's because you CAN only wind a simple toroidal transformer with an integral number of turns, that they are so useful as current transformers for precision measurements. No fractional fittings! When you absolutely HAVE to have an odd multiple of half a turn, you use two toroids and wind around both together as if they were one core. Then you sneak the last turn out early, between the two cores, so it makes a turn around one core but not the other.

It is debateable whether this constitutes one transformer or two, when you come to draw the equivalent circuit. I have also seen a core drilled, to let the half turn pass through. But this is not a simple toroidal transformer.

A toroidal transformer is really a simpler magnetic circuit than an E-I transformer, closer to the theoretical ideal. Yet how many courses cover it thoroughly enough? How many people would get the number of turns right?

Thanks for your comments too, Mr Innes. There's no need to make a wager, though – I'm happy to admit that you're right.

It's interesting that the toroidal transformer hasn't been covered more thoroughly in courses, when you consider its special advantages. Perhaps it was in the 'too hard basket' for so long, in terms of manufacture, that our colleges and uni's regarded it as of little practical relevance.

Now after that short aside, let's return to the subject of esoteric audio cables. And in particular, the response of US designer George Cardas to my discussion of his 'Golden Section Stranding' cables, in the May issue.

Mr Cardas replies

Here's his letter, reproduced in full so that he can make his points unfettered:

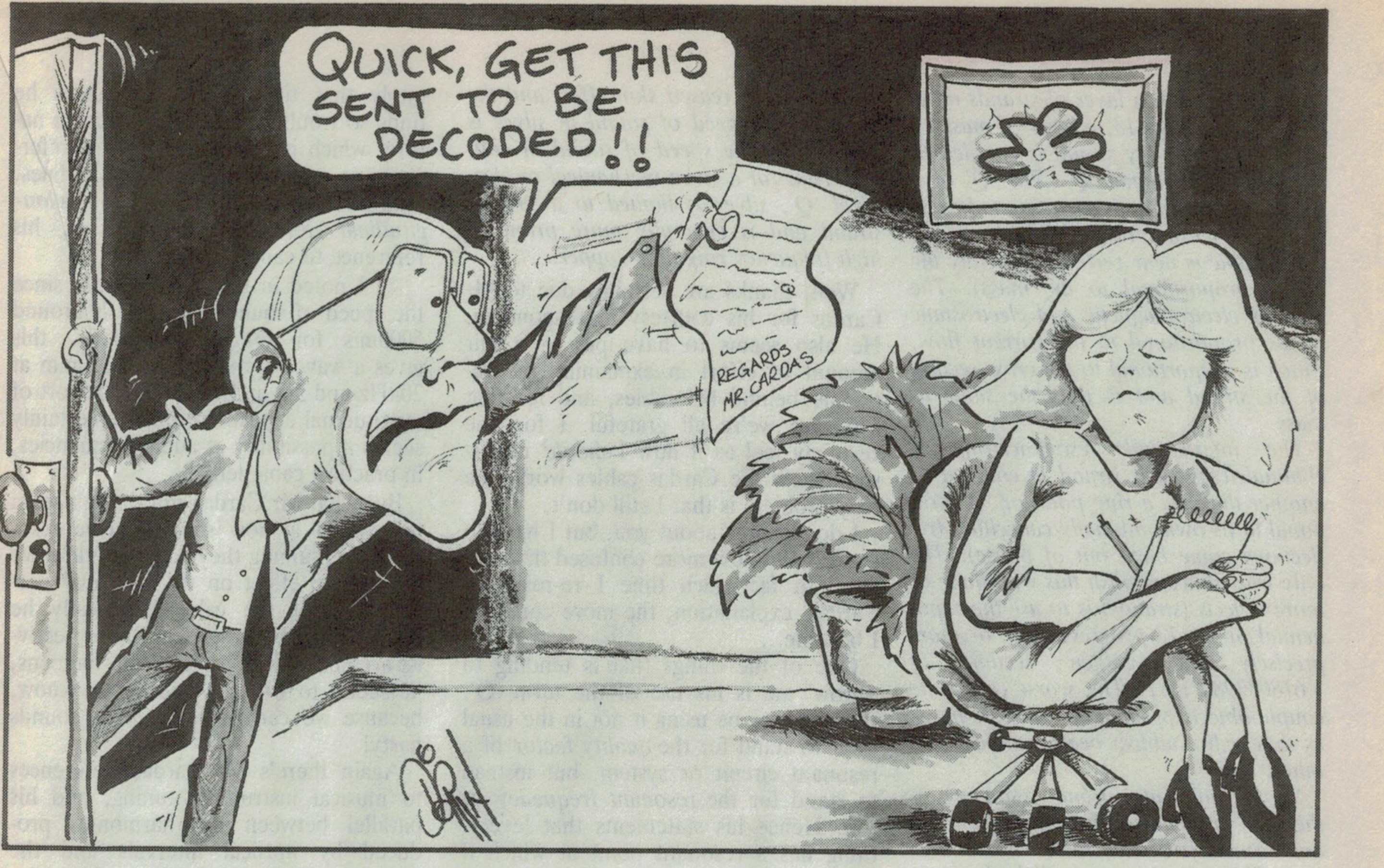
Upland, California.

Dear Mr Rowe,

I certainly appreciate your attention, in 'Oh dem golden cables'. I know that the concept of what I am doing seems a little obscure to most, but the cable demonstrates its sonics quite well in high resolution systems. The reason for this is not so much its linearity as its phase coherence, and lack of inter-transient noise. Differences in phase, and ringing are quite audible in a good imaging system. A fine stereo system is in effect a huge magnifying glass for resonance, and phase problems.

Everything including wire strands, has a resonant point at which it will ring (called a 'Q'). Its ring will be incited by the associated frequency, any harmonic (multiple) of it or any sharp transient change. The further a strand's 'Q' is removed from the audio spectrum the better. Our testing shows that strand sizes exceeding 35awg in copper and 38awg in silver (Note 1) are audibly evident in highly refined systems if their ring is not

Our thanks to Paul Dorin for the cartoon this month – Alan Moir is on vacation.



controlled. Strand sizes below 41awg in any material tend to take on a muffled quality unless the strand coating is very exotic.

By cancelling resonance at the earliest possible point (in the stranding itself) secondary factors such as audible ring, glare and even heat and frictional losses are dramatically reduced. This is not really news; if you read up on power line construction you will find a lot of information on single conductor resonance and frictional losses, and find that the solutions that they have found are very similar to my own. Most current power line construction is basically multi gauge litz wire, believe it or not.

Arguing about the triggers for resonance, be they mechanical, electrical, electromechanical, thermophonic etc., is mute. Demonstrations of alternating current moving the wire and moving wire making current are not new – Alexander Graham Bell observed in 1874 that a simple helix of wire without an iron core emitted sounds and heat when passing current. The sound of the wire (actually it is the first harmonic of the frequency of the current) and the heat are both interrelated to the motion of the wire's molecules, which expand and contract as the current passes.

If you attach probes to each end of a metal guitar string and pluck the string, you can read a distorted version of the resonance on a scope. A shorted line cord on a kicked microphone cable will also 'talk'.

The main thrust of my conductor's design is control of resonance and the associated glare and phasing problems. The use of the exponential or 5-8-13 progression happens to be the best (and most practical) way mathematically to control the multiples upon which resonance thrives. The best way to eliminate resonance is, the coupling masses of irrational (indivisible) 'Q's.

Whether the problem is electrically or electromagnetically is academic; the resultant solution is the same. It is much the same as instrument tuning. As we tune the instrument to an A-E-C progression (major sixth) we find that the beats between the notes go away. These beats are analogous to the dissonance that we hear in the stereo system (the most obvious difference between live sound and a good sound system). As it happens the major sixth (C' – E) is the least dissonant progression (512:320 – 8:5) and the most pleasant to the ear because of the lack of beats between the harmonics.

The use of the exponential progression (5-8-13-21-) to eliminate harmonic dissonance is a natural fact in musical scales, and it is used in speaker boxes and listening rooms extensively. The AES went to a lot of trouble to determine the ideal proportions of a listening space. After a year of playing with moveable walls they determined that the ideal room is 10' x 16' x 26' (you will probably note the 5-8-13 proportion). The reason for this room proportion is that the first major mode in the room is generated by the 10' ceiling dimension and the second major mode is generated by the wall to wall dimension of 16' – the irrational modes 'phase cancel' each other. It does not take much calculation to see that a 10' x 10' x 10' or 10' x 20' x 30' room would be a mistake. I believe that the perfect room would be 10' x 16.18' x 26.18'.

As applied to wire and skin effect etc., it is interesting that skin effect is related to strand size, frequency and current density (resistance of the conductor) and follows the same pattern as a resistance phenomenon. Skin effect is part of the problem and litz wire configurations are demonstrably the best for this and other reasons.

Where resonance more obviously enters the picture is in the inter-strand resonance of the litz wire. This is where my designs best demonstrate their benefits. Basically my conductors are built up onion-skin like, starting with a centre

strand of mass 5, a layer of strands mass 8, a layer of mass 13, a layer of mass 21 etc. This way every strand is coupled to a strand of irrational 'Q'. The 'Q' of a strand mechanically is proportional to its mass and tension (the tension in a seasoned cable is near zero, so basically the 'Q' is proportional to the mass). The strand's electromagnetic and electrostatic 'Q' is proportional to the current flow, which is proportional to the cross-section of the strand and is thus the same as mass.

The inter-strand resonance/ring is eliminated as each strand is coupled to another that has a ring point or 'Q' irrational to its own, mutually cancelling (reflections come back out of phase). The only way to accomplish this with three or more objects (strands) is to use the exponential or 5-8-13 progression – or more precisely the golden section of 1.618033989 to 1. The worst case is to couple objects of equal or multiple mass, as they will establish beats between each other.

Strand and inter-strand resonance is the root mechanism for many of what are termed frictional losses in conductors. Skin effect is a parallel phenomenon with many similarities; the skin effect resistance ratio of 1.247 at 10k in a 10awg solid conductor is obviously significant, but differences in level would not be nearly as noticeable as the associated ring and phase skew would be.

A 10awg single core cable, while having good low bass, screws up the mid and treble. What happens is the treble becomes harmonically detached from the rest of the range, and the overall image disintegrates harmonically and loses focus. The larger the strand, the sooner you hit its 'Q'; the more inductive it becomes, and the narrower its range of resolution. Generally the less resistive a conductor is, the better the dynamics and bass control, and the less its loss. The art comes in getting the low resistance of the large conductors without the problems of the large strands.

The fact that musical notes and mother nature happened to have found that exponential progression makes existence more harmonious should not come as a shock, and can hardly be considered hype by those who appreciate the relationship between natural harmony and music.

Best regards,
George Cardas.

Note 1: The maximum size strand that can be used in silver is smaller than copper, due to increased skin effect and the fact that the speed of sound in silver is slower than the speed of sound in copper. Thus for a given mechanical or electrical 'Q', silver is limited to a smaller strand and is generally more prone to high frequency ring than copper.

Well, thanks are certainly due to Mr Cardas for his courtesy in responding. He also seems to have put in a fair amount of effort in explaining the rationale behind his cables, and for that I'm sure we're all grateful. I for one certainly feel as if now I *should* understand how the Cardas cables work; the only problem is that I still don't.

I don't know about you, but I have to confess I'm now more confused than before. In fact each time I re-read Mr Cardas' explanation, the more confused I become...

One of the things that is tending to 'throw' me is his use of the term 'Q'. He seems to be using it not in the usual way, to stand for the *quality factor* of a resonant circuit or system, but instead to stand for the *resonant frequency* itself. Hence his statements that 'everything has a resonant point at which it will ring (called a 'Q')' and that in his cables, 'each strand is coupled to another that has a ring point or 'Q' irrational to its own'.

Then there's his reference to Alexander Graham Bell's experiment with a helix of wire, which became warm and emitted a sound when it was passing an alternating current. Surely one doesn't have to bring in esoteric theories to explain this – what about plain old resistive losses, and the magnetic interaction between the turns of the helix? The latter even explains the effective frequency doubling for the emitted sound, as the magnetic forces between the turns of the helix are identical for both positive and negative half-cycles of the current.

His reference to voltages generated in a plucked metal guitar string can also be explained quite simply, as due to induction from the magnetic field of the guitar pickups. And as for 'talking' mike cables, it's generally agreed that the microphony is due to the dielectric, not the conductors. Presumably most of the common dielectric materials exhibit at least a small amount of electret behaviour, and generate a voltage when subjected to physical deformation.

But forgetting these points for the moment, there's Mr Cardas' reference to the velocity of sound, in comparing copper and silver wire. This seems to imply that the in-wire resonances he finds so troublesome are *acoustic* in nature, which is consistent with his references to guitar strings and power lines. And he seems to be talking about a *longitudinal* resonance, because of his reference to cable *tension*.

As I noted in the May column, since the speed of sound in copper is around 5000m/s for longitudinal mode, this gives a wavelength of around 250mm at 20kHz and 5m at 1kHz. So some sort of longitudinal acoustic resonance certainly seems a possibility at audio frequencies, in practical cable lengths.

But what Mr Cardas still doesn't seem to explain is how such acoustic resonances, assuming they occur, could have an adverse effect on the *electrical* performance of the cables. Basically he seems to fall back here on the subjectivist argument: who cares how it happens, he seems to write, it does – we know, because we can hear it and it sounds nasty!

Again there's Mr Cardas' references to musical instrument tuning, and his parallel between the harmonies produced by musical intervals and the claimed virtues of having cable wire strands of different 'exponential progression' diameters, so that their acoustic resonance frequencies are supposedly not related harmonically. He really started to lose me there, because my understanding of the nature of musical intervals is that a major interval sounds 'sweet' precisely *because* of the harmonic structure shared by the two notes concerned – not because they *don't* share harmonics.

Essentially beat notes are a sign that two notes or their harmonics *are* very close in frequency, not the reverse. The closer the frequencies, the lower the beat note frequency. Ideally with major intervals the beats are zero not because the frequencies are unrelated in harmonic contact, as Mr Cardas seems to be saying, but because they are coincident.

Of course in practice this often doesn't quite occur, due to the compromises involved in the 'tempered' musical scale to which many instruments are tuned. The exact harmonic coincidence only occurs with 'perfect' tuning. But in most cases tempered tuning seems to achieve harmonics that are close enough for the beats to be relatively unimportant.

The point is, though, that with musical intervals the beats 'go away' not because the frequencies are totally unre-

lated, but because they *are* related. So it seems to me that Mr Cardas' analogy hardly seems to support his case; quite the reverse, in fact.

Despite this he seems to go on and draw another puzzling conclusion: that because in his cables each strand is coupled to strands with non-harmonically-related acoustic resonance frequencies (my interpretation of his term 'a ring point or Q irrational to its own'), this causes mutual cancellation of resonance. And apparently this is because 'reflections come back out of phase'.

Come again? Surely the only way that reflections would 'come back out of phase', and produce cancellation, would be if the coupled strands *were* resonating at the same frequencies – so that the overall reflection path length was somehow an odd multiple of a half wavelength.

In short, this aspect of his explanation just doesn't seem to make much sense.

Frankly I think his 'room dimensions' analogy is rather more useful, and relevant. My understanding is that rectangular rooms with differing dimensions sound better because the resonant frequencies in the various modes *are* different, providing minimal mutual reinforcement and tending to even out the 'bumps and lumps' in the overall room response. It seems to me that the same kind of argument could conceivably be used for Mr Cardas' cable strands, assuming as before that the acoustic resonances of the strands could be shown (a) to occur, and (b) to have an adverse effect on their electrical behaviour.

Presumably then the different resonant frequencies of the strands would tend to even out any bumps and lumps in the cable performance, particularly if the resonant frequencies were deliberately chosen to be not related harmonically – at least in the audible part of the spectrum.

The only problem is, does Mr Cardas design his cables to make these supposed resonances inharmonically related, or not? After reading his explanation, I'm blessed if I know; despite what he seems to be claiming, some of what he writes seems to imply the exact opposite.

And what about those 'resonances' – *do* they exist? Mr Cardas' main argument seems to be that they do, because (a) he and others can hear their ill effects and (b) his cables, designed to minimise such resonances, solve the problem.

Apart from that, the only evidence I can find in his letter is the suggestion that because skin effect is 'related to strand size, frequency and current density (resistance of the conductor)', it supposedly 'follows the same pattern as a resonance phenomenon'.

Again he loses me with that bit of reasoning. Even assuming that skin effect is significant at audio frequencies – a point which we've looked at before, and is the subject of ongoing debate – the fact is that it essentially increases smoothly with frequency. In itself it produces no 'peaks' in behaviour at particular frequencies, or anything else even remotely like a resonance. So exactly how the two phenomena can be said to follow the same pattern is not at all clear, at least to me.

By the way, did you notice that nowhere in Mr Cardas' letter did he refer to the 'big wires for bass frequencies and little wires for treble frequencies' claim, which seemed to figure in the daily press items on his cables?

In fact the only faint reference I could detect was in his first paragraph, where he talks about 'phase coherence' and 'phase problems'. The funny thing is, there seemed to be no reference to frequency-dependant phase shifts anywhere else in his letter – only a lot of stuff about resonances.

If there's a connection there, I must have missed it.

On the whole, then, I confess that I for one don't find Mr Cardas' letter very illuminating. Somehow he seems to be saying something along the lines that thin wires have too much skin effect, but thick wires have worrying resonances – so the best approach is to use a combination of many different diameters.

Whether this is really what he's saying, I'm not sure – let alone whether he's right. And of course quite apart from all of this theory, there's the separate question of whether or not Mr Cardas' cables actually sound better than ordinary cables.

The funny thing is, I'm about to find out for myself.

By sheer coincidence, and as a different kind of response to some of the recent Forum columns, Trevor Wilson of ME Sound and some of his colleagues in the 'Oz Hifi' organisation decided to ensure that I got to hear a really top-quality stereo system using largely Australian designed and manufactured components. So just as I'm finishing off this month's column, they've delivered to my home a very impressive set of components – a pair of massive speakers about five feet high, a thumping great ME power amp and preamp combination, and a top of the range CD player.

And guess what kind of interconnecting cables and speaker cables they sent along, to make sure I get the best results when I hook everything up? You guessed it – Cardas cables.

I hesitate to think what it's all worth. I suspect that the Cardas cables alone are worth more than my complete existing stereo system!

Needless to say, the system is only on loan, for a couple of weeks. But it will provide an excellent opportunity not only to try out some impressive examples of top-drawer Australian hifi component design and manufacture, but also to see if my family and I can hear the improvement offered by Mr Cardas' cables – on a system that surely qualifies for his 'high resolution' rating.

Even though his explanation didn't win me over, perhaps his cables will. I'm looking forward to finding out!

By the way, I'm also planning to use the same system to try those QED 'Incon' and Hitachi LC-OFC interconnecting cables again – comparing them with each other, the Cardas interconnection cables and an 'el-cheapo' interconnection lead. It should be interesting, don't you think?

Stay tuned next month, for the next exciting episode.

SHORTWAVE LISTENING

by Arthur Cushen

Rhema establishes expansive Gospel network

New Zealand now has one of the largest networks of private non-commercial stations. By the end of the year, Radio Rhema will be operating 12 mediumwave and one FM station.

Radio Rhema is a non profit, non commercial gospel network. In 1968, a church property was purchased at Glenfield Crescent in Christchurch, and it was here on November 23, 1974 that the first real breakthrough in Christian broadcasting took place. Although Radio Rhema was granted only a one-day licence, the matter was pursued and on November 11, 1978 an even greater event took place as Radio Rhema began broadcasting on a full-time basis. This was a milestone for Christian broadcasting, not only in Christchurch and New Zealand, but also throughout the British Commonwealth.

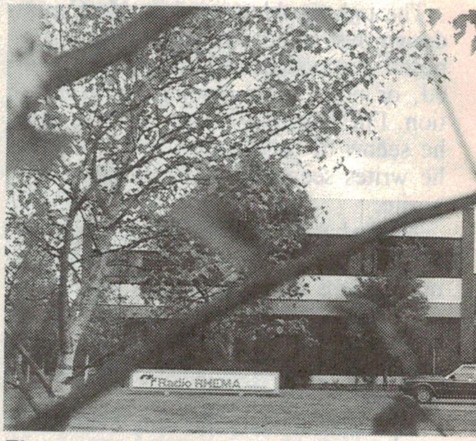
Within a few years, Wellington (March 1982) and Nelson (May 28, 1983) had also come on air and it seemed as if the trials and tribulations of the past were now well and truly behind the stations.

A fourth station was established in Hamilton (opened July 31, 1988) followed by further stations opened in 1989 including Tauranga, Taupo (FM), Invercargill, Timaru and Dunedin and in 1990 Napier, Gisborne, New Plymouth and Wanganui-Palmerston North are planned.

Radio Rhema originates many of its network programmes from the studios in Christchurch, but there are also broadcasts coming from the Auckland Studios, while other stations have their own breakout for local programming. The network operates 1800-1200UTC and has news on the hour every hour, while *Arthur Cushen's Radio World* is carried on Friday at 1100UTC. The mailing address is Radio Rhema, Private Bag, Christchurch NZ and the complete list of stations operating at the moment is as follows:

kHz	Call	Location
540	1XC	Tauranga
540	2XC	Gisborne
594	3XL	Timaru
621	4XG	Dunedin
648	2XH	Napier
801	2XL	Nelson
855	1XH	Hamilton
1251	1XG	Auckland
1404	4XL	Invercargill
1503	2XG	Wellington
1503	3XG	Christchurch

Power is 5kW in all cases except 2XL and 3XG, which are 2kW.



The studio buildings of Radio Rhema Christchurch, from which

AROUND THE WORLD

AUSTRIA: Vienna is broadcasting in English 0530-0600 on 6015; 0730-0800 on 6155, 13730, 15450, 21490; 1030-1100 on 15450, 21490; 1130-1200 on 6155 and 13730kHz.

NEW ZEALAND: Radio New Zealand International 'Mailbox' is now repeated on the first and third Friday of each month. The programme contains Tony King answering letters and DX news from Arthur Cushen. The first broadcast is on the first and third Monday of each month at 0430UTC up to October, when it will move to 0330. It is heard on 17680kHz, and the repeat is the following Friday at 1905UTC.

NORWAY: Radio Norway, Oslo, broadcasts in English every Sunday and there are three transmissions suitable for reception in the South Pacific. The programme is repeated several times to reach listeners all over the world at convenient hours. 'Norway Today' contains a survey of the main news events from the past week in addition to interviews, short features and music. Listeners' comments are appreciated. The postal address is Radio Norway International, Bjoernsons Pl.1, 0340 Oslo 3, Norway. Transmissions best received in this area are: 0600 on 15165; 0800 on 15165, 25730 and 0900 on 17840.

USA: The VOA in its broadcast in English to the South Pacific is using the following schedule: 1000-1100 on 5985, 11720, 15425; 1100-1200 on 5985, 6110, 9760, 11720, 15155, 15425; 1900-2000 on 9525, 11870, 15180; 2100-2200 on 11870, 15185, 17735; 2200-2400 on 7120, 9770, 11760, 15185, 15290, 15305, 17735, 17820.

WESTERN SAMOA: 2AP Apia on 540kHz commenced operation recently using a 400 foot tower, while a second transmitter is expected to use 747kHz. These transmitters were not damaged by the hurricane. The transmitter on 1404 is being retained for Civil Defence emergency and 1359 has been reactivated, but the old transmitter on 540 was destroyed by the hurricane and 1251 is being closed down. The new site for the 540kHz transmitter is by the sea on the Mulinuu Peninsula, just across from the radio station. The two frequencies will use 10kW transmitters which have been donated by the Australian Government.

Canada expands relays

Radio Canada International is continuing to expand its use of overseas stations, in a cooperation agreement in which time is shared on other stations' transmitters.

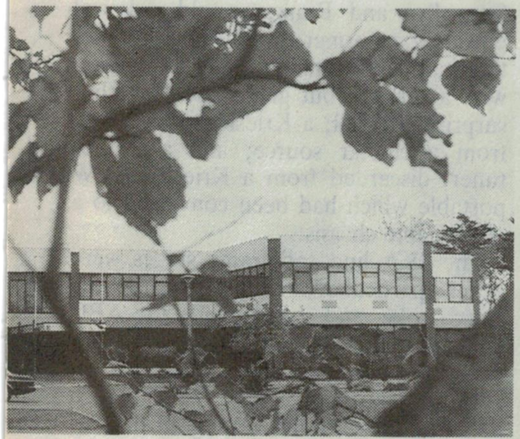
The latest agreement is between Radio Canada and the Korean Broadcasting System, and broadcasts from Montreal are now beamed to Asia in Chinese and Japanese. The schedule is 1300-1325 in Chinese on 6150; 1330-1357 in Japanese on 6095, 9700 and 1430-1455 again in Chinese on 9700kHz.

Radio Canada is also being relayed to Asia through the transmitters of Radio Japan at Yamata and through Radio Beijing's transmitters. In Europe broadcasts from Montreal are carried through BBC transmitters at Daventry in several European languages, while the use of the Austrian Radio transmitters carry programmes to the Middle East.

The relay via Austrian Radio is 0300-0400 on 11730 and 0400-0500 on 15275kHz. These broadcasts are in French and English, while transmissions in Arabic are planned for the future.

Radio Canada International with its services to Europe provides morning reception in the South Pacific 2100-2159 on 15325 and 17875, while a further broadcast is beamed to Africa 2130-2159 on 11880, 15150 and 17820kHz. The broadcast Monday to Friday of news 0500-0600 has been altered. French is carried 0500-0515 and English 0515-0600. The frequencies include 6050, 6150, 7295, 9750, 11775 and 17840kHz.

This column is contributed by Arthur Cushen, 212 Earn St, Invercargill, New Zealand, who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT), which is 10 hours behind Australian Eastern Standard Time.



programmes originate to a 12 station network.

The Serviceman

The tale of a set called 'Frank' – a bit like grandpa's axe!

This month we devote the whole column to just one contribution. It comes from K.W., from Lane Cove NSW, who tells a long and convoluted story about his parents' television set – which during its life has been several different models.

K.W.'s set has been 'modified' so many times that, while reading the story, I find it hard to remember which model is the current one. But I'll let K.W. tell the story in his own way, and as it's fairly long, we'll forget the usual convention of putting it in italics:

With the increasing difficulty in obtaining spare parts for older TV receivers these days, most technicians have to rely more and more on component substitution. For things like electrolytics, transistors, diodes and to some extent EHT triplers this is not a major problem for a competent serviceman and (apart from crook solder joints and the like) most faults seem to involve this sort of component.

ICs can present a supply problem but fortunately, they tend to be quite reliable.

Back in the early 1970s, when most sets still used valves, there was a small but thriving industry supplying replacement parts for old sets whose manufacturers had either disappeared or abandoned them. Thus, there were all sorts of 'universal' components available but in many cases, some modifications to the set were required.

This was all considered fair and above board; certainly better than scrapping the set, and it would usually work as well as ever afterwards. However, there was another – all too prevalent – practice, known in the trade as 'butchery'.

Now most people would imagine that term referred to the activities of someone who was terrible at soldering, generally inept or something similar. Actually, it refers to the practice of 'modifying' the design of a set simply to make it work, rather than curing the actual fault.

For example, if the vertical hold control didn't have enough range, (often due to a leaky paper capacitor in those days), they might solder a fixed resistor in series with the pot to 'improve' the hold range. Usually this was for no other reason than because the control was easier to get at...

One particularly memorable case of butchery I heard about was the 'gentleman' who used to cure AGC problems in old valve sets by soldering a nine volt battery across the AGC line! Another reprehensible practice was to cure lack of height or width by resetting the mains input to the power transformer to a lower voltage. Thus there might be 240 volts applied to the 220V input. This would slowly kill off all the valves in the set.

Apart from the possibility of actual damage to the set, the trouble with this sort of 'cure' is that the offending component usually deteriorates still further, so the fault eventually reappears.

Modern solid-state colour TV sets are far less amenable to this sort of 'service', since their faults, (intermittent or otherwise), tend to be of the all-or-nothing variety. Where component drift does occur, it can usually be cured legitimately by adjusting the relevant pot – adding extra resistance is rarely beneficial!

But what happens when you're forced (by time or financial constraints), to resort to some form of 'temporary butchery' and the set winds up working as well as or better than it did originally?

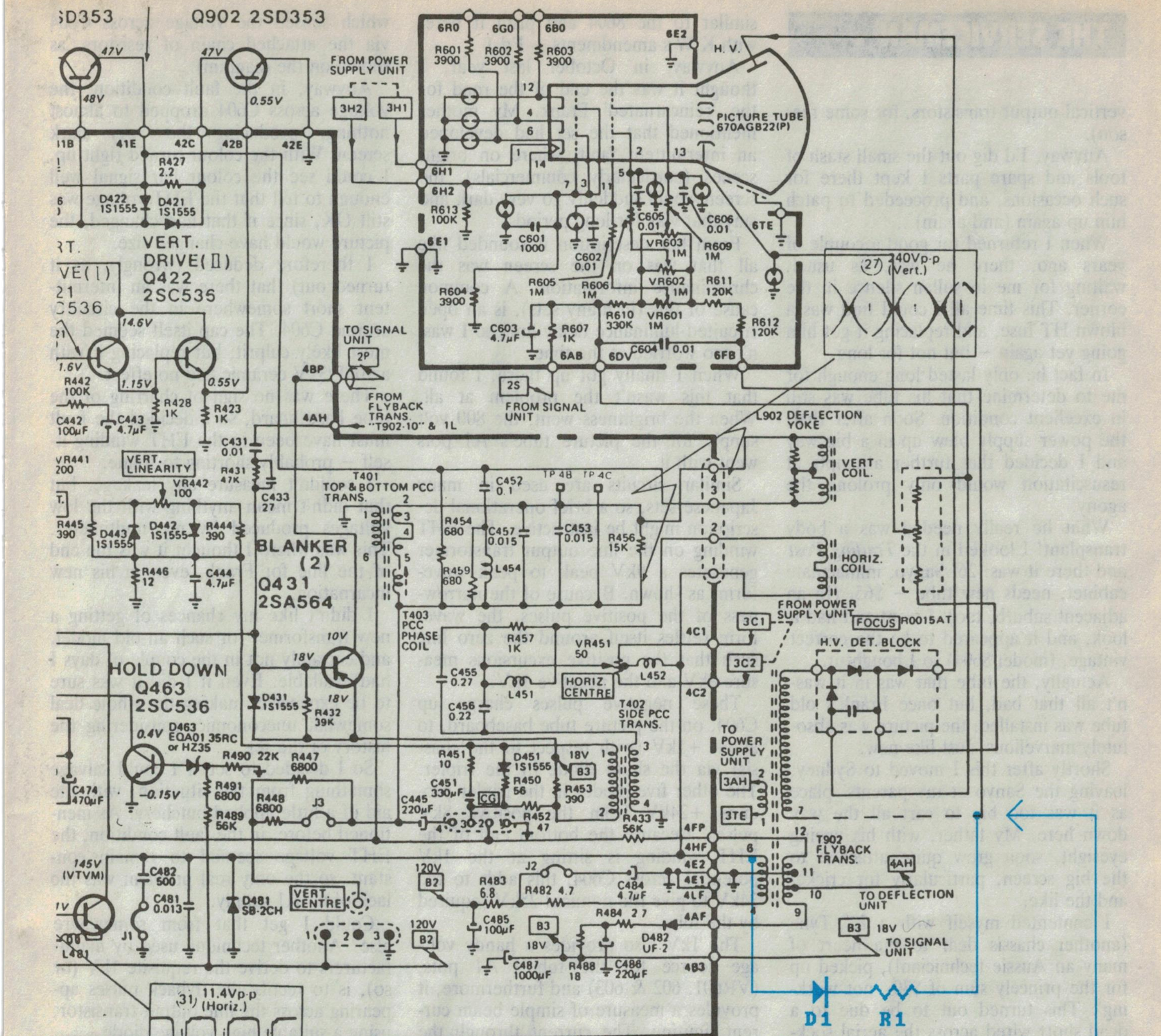
This happened to me recently. I don't feel any remorse, guilt, pangs of contrition, etc, since it was my own set (although it resides at my parents' place). As a lot of these sets are written off for this particular fault, the following story may rescue some from the scrap pile.

(Stay with us, dear reader. It takes K.W. quite a while to get to the point! Ed.)

The story actually begins in the late 1970's, when colour TVs were expensive and many technicians were entertaining thoughts of building our own – from whatever bits we could scrounge from various manufacturers.

Many such projects were started, but I was one of the few who actually got their set going. And what a Frankenstein's monster it was too, with a Sanyo 670RB22 tube and yoke; a mostly Thorn 4KA chassis with 'contributions' from Pye and Rank; an old Admiral power transformer; a National cabinet that had been 'totalled' in an altercation with a forklift, but glued back together surprisingly well; a Kriesler escutcheon, from a similar source; and a Philips tuner, discarded from a Kriesler B&W portable which had been converted to a video game chassis.

The 4KA line and frame stages were never particularly happy driving the Sanyo yoke, and consequently the ABC test circle had a distinctly 'square' appearance; but this wasn't really noticeable on a normal picture. There was a lot of fiddling around getting all the different bits to work together but overall, the results were pretty good.



The horizontal output section of a Sanyo 8604 CTV (one of Frank's incarnations), showing K.W.'s rather intriguing 'mod'...

So – did I then settle back to enjoy many years of happy viewing, with the added satisfaction of knowing I built it myself? Well, no.

No sooner had I completed this masterpiece than I was offered a fairly new 'store-bought' 67cm colour set for $100, not working. It was a version of the Thorn 3500 chassis, made in the UK for the German market, under the name 'Carad', and featuring VHF and UHF varicap tuners and a quite stylish white cabinet in perfect condition.

Many technicians have developed a deep hatred for the 3504 chassis (the version of the 3500 sold in Australia), but I never had any problems with them – although a stint working for the AWA/Thorn service department undoubtedly helped.

Anyway, the set turned out to have only a very simple power supply fault but the owner hadn't been able to get anyone to fix it. Thirty minutes or so later I had it up and running with a first-class picture.

The 'Frankenstein' receiver found a home with some impoverished relatives while I subsequently moved to New Zealand, taking my new acquisition with me. (A very similar model was manufactured there, making spare parts no problem). As far as I know, it's still doing sterling service.

I lived in NZ for nine years and every time I made a visit home (to Brisbane) they'd drag out 'Frank' – who'd invariably karked it yet again during my absence. (He was particularly hard on

vertical output transistors, for some reason).

Anyway, I'd dig out the small stash of tools and spare parts I kept there for such occasions, and proceeded to patch him up again (and again)...

When I returned for good a couple of years ago, there he was, as usual, waiting for me in sullen silence in the corner. This time all I could find was a blown HT fuse, and replacing it got him going yet again – but not for long.

In fact he only lasted long enough for me to determine that his tube was still in excellent condition. Soon after that, the power supply blew up in a big way and I decided that further attempts at resuscitation would only prolong the agony.

What he really needed was a body transplant! I looked in the *Trading Post* and there it was: 26" Sanyo, immaculate cabinet, needs new tube – $65. (In an adjacent suburb, too). I went and had a look, and it appeared to be the correct vintage, (model 8604) so I bought it.

Actually, the tube that was in it wasn't all that bad, but once Frank's old tube was installed, the picture was absolutely marvellous. Just like new.

Shortly after this I moved to Sydney, leaving the Sanyo at my parents' place as it was too big to cart all the way down here. My father, with his ageing eyesight, soon grew quite attached to the big screen, particularly for cricket and the like.

I contented myself with a 22" Tyne (another chassis dear to the heart of many an Aussie technician!), picked up for the princely sum of $30, 'not working'. This turned out to be due to a dead short wired across the aerial socket. For what reason, I can't imagine!

Unfortunately, the Sanyo wasn't without its share of teething troubles, and the previous trans-Tasman dramas were repeated to some extent – although it's a lot easier to get to Brisbane from Sydney than from Auckland!

It pulled the usual Sanyo stunts – the 4.7uF electro on the CRT's base board drying out, making the picture very dark, and the crook 330uF bipolar capacitor in the vertical circuit, causing horrendous pincushion distortion.

Easy enough to fix, except it had to wait until I was back up there to do it. Also, I've been out of the domestic TV service game for some years and thus don't have ready access to circuit diagrams. (We've located a diagram very similar to the 8604 and print it here, with K.W's amendments – Ed.)

Anyway, in October last year, I thought it was the end of the road for the 'reincarnated' Frank. My mother mentioned that the set had developed an intermittent fault, where on bright scenes (particularly commercials), the screen would suddenly go very dark and stay that way for long periods.

From her description it sounded like all that was on the screen was the chrominance information. A common cause of this (in many sets), is an open circuited luminance delay line, so I wasn't too worried at the time.

When I finally got up there, I found that this wasn't the problem at all. When the brightness went, the 800 volt supply for the picture tube's A1 pots went with it.

Similar circuits are used in many Japanese sets, so a brief operational description might be instructive. The EHT winding on the line output transformer generates a 9kV peak to peak waveform, as shown. Because of the narrowness of the positive pulses, the waveform settles itself around the zero line such that the positive excursions measure 8kV and the negative 1kV.

These negative pulses charge up C604, on the picture tube baseboard, to about +1kV (with respect to the chassis) via the shunt diode in the tripler. The other five diodes in the tripler produce +24kV from the positive 8kV pulses. Because the bottom end of the EHT winding is sitting at the 1kV potential across C604, this adds to the 24kV to give the nominal 25kV required by the tube.

The 1kV also provides a handy voltage source for the tube's A1 pots, (VR601, 602 & 603) and furthermore, it provides a measure of simple beam current limiting. The current through the shunt diode and that through the other five diodes in the tripler essentially flow in opposite directions.

When the beam current is low, C604 will be charged up to the full 1kV, giving maximum A1 voltage. As the beam current increases, the opposing current flow this generates will tend to reduce the voltage across C604 and so reduce the picture brightness.

In the case of an extreme overload condition, such as might occur if the HT supply to the video output transistors were to fail, the A1 voltage will drop to a very low value, preventing excessive tube current and protecting both it and the tripler. (Apparently, this mechanism wasn't effective enough for Sanyo, so they added an auxilliary beam limiter which sensed the voltage across C604 via the attached chain of resistors, as shown on the diagram).

Anyway, in the fault condition, the voltage across C604 dropped to almost nothing, producing the very dark screen. With the colour turned right up, I could see the colour bar signal well enough to tell that the EHT voltage was still OK, since if that had changed, the picture would have changed size.

I therefore deduced (wrongly, as it turned out) that there was an intermittent short somewhere in the circuitry around C604. The cap itself seemed the most likely culprit, but replacing it with a 10nF/3kV ceramic had no effect.

There was no sign of charring of the tube base board, so I decided the fault must have been in the EHT winding itself – probably shorting to frame.

I couldn't measure any leakage, but that didn't mean anything with the low voltages produced by my multimeter. This was where I thought it was the end of the line for Frank, even in his new incarnation.

I didn't like my chances of getting a new transformer for such an old model, and certainly not in the couple of days I had available. Even if I did it was sure to be expensive, making the whole deal somewhat uneconomic, considering the history of the set.

So I decided to see if I could salvage something from the situation, with the aid of a little applied butchery! As mentioned before, in the fault condition, the EHT voltage seemed to remain constant, so the only real problem was the lack of an A1 supply.

Could I get that from somewhere else? Another technique used by manufacturers to derive the requisite 1kV (or so), is to rectify the flyback pulses appearing across the line output transistor, using a suitable high voltage diode.

All I had to do to try this was lift the wire going from the EHT winding to C604 and then fit a diode between C604 and the line output transistor's collector.

The wires going to the collector of the line output transistor and C604 on the CRT base board were on adjacent pins of the line output transformer, so it was a simple matter to fit the rectifier diode as shown on the diagram.

The diode I used was a 1S2711, a 1.5kV, 5A type that I just happened to have lying around. These were often used as damper diodes in Japanese colour sets, so I was confident it would handle the situation OK.

I'm not sure what the 2.2k resistor actually does, but where this sort of cir-

cuit is used, the manufacturers seem to like using such a series resistor, so I thought I'd play safe and fit one too!

Now I wasn't expecting miracles, but I hoped this would restore some semblance of life to the set. Of course the beam limiter would no longer work but since my parents rarely touched the brightness or contrast controls, I thought we could live with that.

I didn't know what sort of A1 voltage was going to be developed by the new circuit, so I crossed my fingers and switched the set on, ready to switch off at the first sign of distress.

It was a bit of an anticlimax, actually! The set came to life just as it had always done and, apart from the fact that I'd wound the colour right up earlier, the picture was fine. I didn't have to readjust the A1's or anything.

The lack of beam limiting seemed to be no problem either. Even with an uncomfortably bright screen, there was no sign of picture distortion or distressed noises from the power supply.

While congratulating myself on my resourcefulness, and as a final gesture to Frank's future reliability, I thought I'd better make sure the intermittent short became permanent, otherwise there could be internal arcing which might damage the transformer.

With the set still running, I went to clip an earthed jumper lead onto the now disconnected EHT winding terminal. However, I didn't get that far! While the croc clip was still a couple of millimetres away, a fat purple spark leapt out at it and the power supply shut down with screech of outrage.

The set came on again immediately, none the worse for the experience but leaving me greatly puzzled. If the winding wasn't shorting to ground, then where was it shorting to? There must have been at least 3kV AC on that terminal and as far as I knew, there was no other connection to the transformer with that much juice on it!

Had I completely misunderstood the circuitry? (Remember, I was working without a circuit diagram). I got out my multimeter and checked for continuity between the tripler end of the EHT winding and any of the other pins on the line output transformer. There was none.

In fact I couldn't find any DC continuity to anywhere in the set – yet it worked! I decided it was time to phone my friend Noel. Noel once worked for Sanyo, and has helped me out before with problems in Sanyo's (and many other makes too for that matter), often being able to give the circuit reference off the top of his head.

Yes, he knew the fault very well. It wasn't a short; the problem was always the winding going OPEN circuit. The transformers were still readily available too, about $36 plus tax – ironically from a place in Sydney not too far from where I live!

So why was it still working? Well obviously, the winding's capacitance to ground provided a sufficiently low impedance AC path to allow the tripler to function apparently normally.

Unfortunately, this provided no DC path to allow C604 to charge up, hence the dark screen. On the other hand, it must have been only a small break, as the earthed jumper lead was obviously too much of a temptation for the high voltage to resist.

I can see how it could work, but what astounded me was how WELL it worked. There was literally nothing wrong with the picture. No sign of blooming, de-focussing or any other sort of picture disturbance.

Noel had never heard of anyone resurrecting a set the way I did, but he was keen to try the technique. Next time he gets lumbered with a 'love job' with that fault, he's promised to give it a go!

That was over five months ago and the Sanyo hasn't missed a beat, despite several hours' use nearly every day; so I've pronounced it cured. Some zealots may point the finger of scorn at me for using such an idealogically unsound repair technique, but I can't see any harm in it. The set works as well as ever and I can't see how any dangerous fault could develop from the repair.

Even if the transformer does eventually fail for good, I won't be any worse off. After all, it is my own set and what consenting technicians do to their own sets, in private, is surely their own affair!

Yours truly returns

Well, I've heard of some 'modifications' in my time, but K.W's 'Frank' sounds to me a bit like grandfather's axe – eight new handles and three new heads, and it's still as good as new!

The story just goes to show that any TV can be repaired, if only you are prepared to spend enough time on the job. In K.W's case it was his own time, so money didn't come into it. If he had had to pay a technician umpteen dollars an hour to do the work for him, it would have been a different story.

Then again, I don't know if I would have the patience to persevere with a job like that. I suppose that when keep-

THE SERVICEMAN

ing an old set going is a labour of love then time and effort do not come into the question. I'm sure that K.W.'s parents appreciate his devotion to keeping 'Frank' alive.

Now to technicalities.

I'm just as puzzled as K.W. about why the tripler continued to work when the EHT winding was open circuit. Any stray capacitance would be distributed along the full length of the winding, making that part of the circuit more like a delay line than a high voltage generator. What it would do to the waveform of the input to the tripler cannot be imagined.

I can't help wondering what the power supply would have said about grounding the bottom of the overwind with the set switched 'off'. I feel that the winding should be returned to somewhere; through a limiting resistor, perhaps.

But just a minute! Unless K.W.'s Sanyo 8604 is different to mine, the tripler isn't a tripler at all but a doubler. The 'HV DET BLOCK' in the circuit diagram has only two series diodes and one capacitor. This couldn't triple anything.

If this diagram is a true representation of the insides of the HV block, it means the device has to be fed with 12-13kV, and maybe this brute force treatment brings about the result that K.W. reports. It's all just too confusing!

On the subject of beam limiters, I have often wondered about these circuits. I have only once found a set that needed the circuit – a Philips that shut down on beach or snow scenes! Repairing the beam limiter circuit restored normal operation.

In most other sets I've handled, the beam limiter only stopped the contrast from going unnaturally high. I've often thought that they should be labelled 'Contrast Limiter' instead of beam limiter.

As K.W. found, the lack of an effective beam limiter has little effect on the picture. The circuitry needed to provide the feature would seem to be an unnecessary complication in what was already a complicated piece of circuitry.

Well, that's all for this month but before I go, I'd like to appeal for contributions from technicians working on something other than domestic electronics.

I think we'd all be interested to hear stories on subjects like marine or medical or industrial electronics. And what about the armed services? There must be a wealth of stories about field service of their electronic equipment.

I'll be back next month with more interesting material from the workbench.

Fault of the Month

Sanyo CTP 7605A

SYMPTOM: No go. No voltage across collector/emitter of chopper transistor, but normal output can be measured across bridge diodes. Fuses and primary of chopper transformer are OK.

CURE: Dry joint at mounting post of C310. The can of this large electro forms a link between the bridge negative and the emitter of the chopper transistor, and the two mounting posts must be securely fixed to the copper track.

This information is supplied by courtesy of the Tasmanian Branch of The Electronic Technicians' Institute of Australia (TETIA). Contributions should be sent to J. Lawler, 16 Adina Street, Geilston Bay, Tasmania 7015.

READER INFO No. 10

Diodes and rectification

The simplest semiconductor device is the diode. It's amazing what this component can do, and in this chapter we describe the diode and show how it is used to convert AC to DC.

by PETER PHILLIPS

Over the last six chapters of this series, we have covered most of the so-called 'passive' components used in electronics. A passive component is one that needs no external power supply to operate; instead it is used within a circuit to modify voltage or current values.

The diode is another passive component, and has been around in one form or another since the dawn of electronics. The basic feature of a diode is that current can only flow *one* way through the device. A simple function, but incredibly useful in electronics.

The earliest type of diode was the thermionic valve, followed by the cat's whisker diode as used in the first crystal radios. These days, diodes are constructed using semiconductor materials, and this is the type of diode we will describe in this chapter. As the construction of a diode is fundamental to many semiconductor devices, we will spend some time just looking at the operation of semiconductors in preparation for the transistor and other such components.

And to get practical, we also look at how a diode can turn AC into DC. Yes, it's time to start combining all the components described so far into something useful.

The diode

As we've already said, a diode is a device that allows current to flow through it in one direction only. When electronics was in its infancy, the diode valve was invented. This simple device, which is still in limited use today, consists of two *electrodes* in an evacuated glass envelope. The electrodes are called the *anode* and the *cathode*, usually labelled as 'A' and 'K'. The K comes from the German term 'kathode', and these days, it is usual to refer to the terminals of a semiconductor diode in the same way.

In the valve diode, the cathode consists of a metal tube coated with a material that, when heated, emits electrons. To heat the tube, a heater is required and like all valves, power must be supplied to the heater for the valve to operate.

By applying a positive voltage to the anode and a negative voltage to the cathode, electrons are attracted across the vacuum from the cathode to the anode and a current will flow. But if the anode of the valve is made negative and the cathode positive, the electrons from the cathode simply stay there, and no current flows.

In Chapter 1 we stated that an electrical current flows in the opposite direction to electron flow. Thus: *current in a diode flows from the anode to the cathode, providing the anode is positive with respect to the cathode.*

The symbol for a diode is shown in Fig.1. Like many symbols used in electronics, an arrow of some sort indicates the direction of current flow. That's *current* flow, not electron flow by the way. This is the main reason why we are sticking to conventional current flow, as the symbols point in the right direction.

If the anode of a diode is positive with respect to its cathode, the diode is said to be *forward biased*, as in Fig.1(b). If the polarities are reversed, the diode is *reverse biased*, and no current flows as depicted in Fig.1(c). The term *bias* is used to describe the DC conditions, and if a diode is always forward biased by the DC conditions, it is therefore always conducting and can be viewed as a closed switch.

Now that we've described what a diode does, we can start down the track of looking at semiconductors. From there it's a small jump to the semiconductor diode.

The semiconductor

The term 'semiconductor' suggests that the material is neither an insulator or a conductor. But a resistor does the same thing you say, and a resistor is definitely not a semiconductor. Quite right.

As it turns out, a slab of semiconductor material has resistance, but it also possesses other properties that put it into a class of its own.

The two most common semiconductor materials are silicon and germanium. In their pure state, both these materials have certain properties that while unique, are not generally useful on their

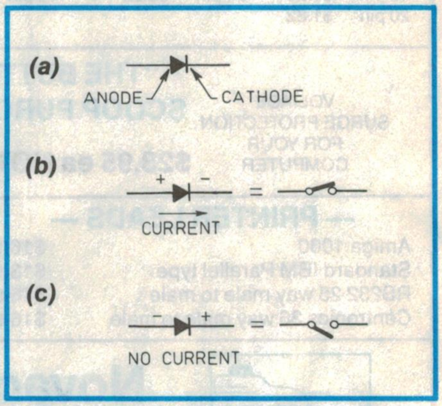
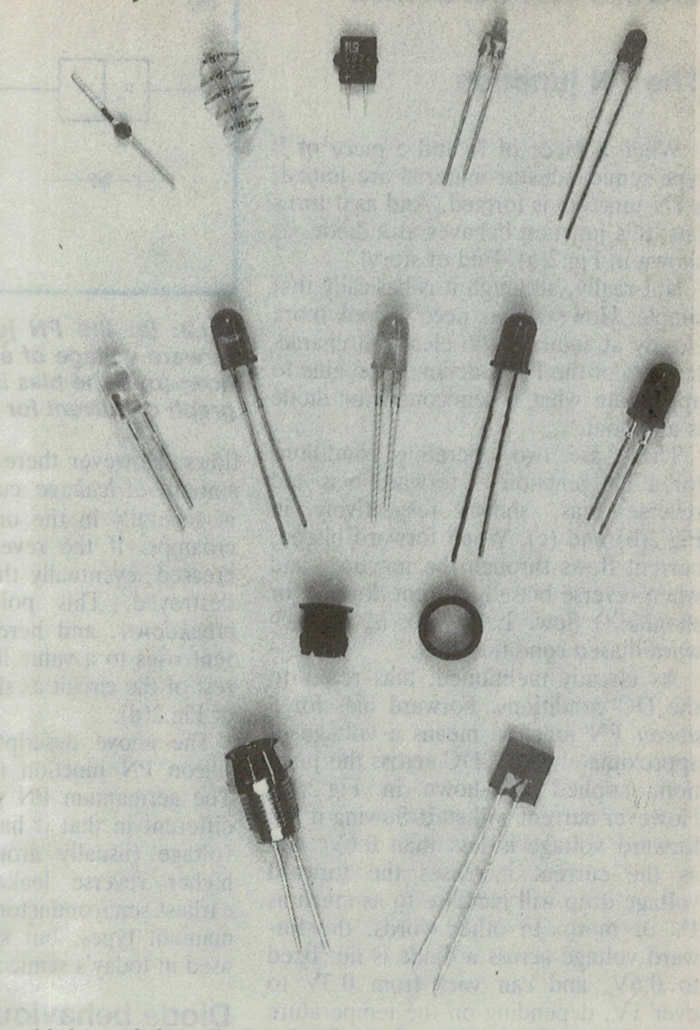
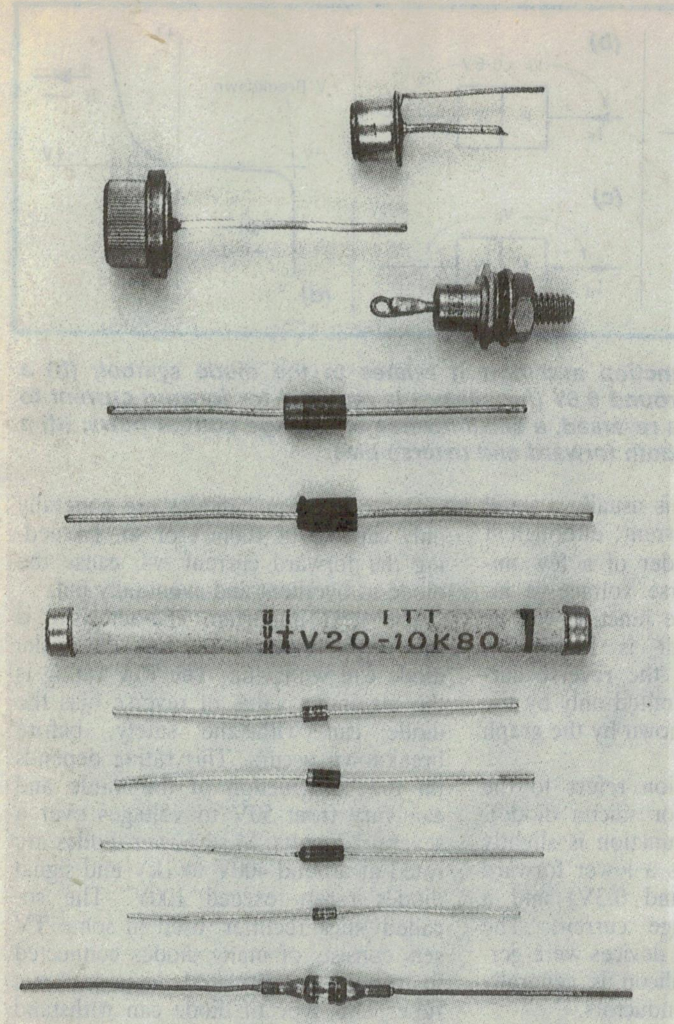


***Fig.1:** The symbol for a diode is shown in (a), while (b) and (c) illustrate that current only flows if the anode is positive and the cathode negative.*



Light emitting diodes are made in a range of colours and package styles. The top row shows a range of small LEDs with the popular 3mm red LED on the right. The centre row shows a range of 5mm LEDs, with a high intensity type on the left, a flashing LED next to it, and an infrared LED on the right. The mounting hardware is shown beneath. A rectangular LED and a LED fitted to a bezel are in the bottom row.



Diodes come in all shapes and sizes. From top to bottom: a glass encapsulated crystal diode, two signal diodes, two 1A rectifier diodes, a 'stick' rectifier that can withstand a PIV of 20kV, two 3A power diodes, a stud mount 10A diode, a press fit automobile diode and a 3A metal encapsulated diode.

own. A unique feature of a semiconductor material is the atomic structure of the atoms that make up the material.

Without getting too involved in a chemistry lesson, all atoms consist of a nucleus surrounded by orbiting electrons. In a semiconductor, the structure of the atoms that make up the material is such that they allow electrons to move from one atom to the next – somewhat less freely than a conductor, such as copper, but better than an insulator. Hence the term *semiconductor*.

However, the atomic structure allows it be 'doped'. This refers to the addition of an impurity which effectively creates spare *carriers* within the material that enhance its conductivity. Semiconductor theory is difficult to describe in simple terms, and some text books go to great lengths on the subject. Generally, it is not necessary to understand the innermost workings of a semiconductor, and we will leave it to you to research the topic elsewhere if you feel the need.

In basic terms, a block of pure silicon or germanium can be *doped* to create either so-called 'P' type or 'N' type materials. For want of a better description, the P type is doped so that is has extra 'holes' (or lack of electrons), and the N type has extra electrons. These extra holes and electrons are called *carriers*, because they're able to carry a current.

Doping is achieved in a number of ways, and involves the addition of small quanities of an element such as phosphorus, arsenic or antimony. One method is to expose the pure semiconductor material to the dopant in the form of a hot vapour, in a 'diffusion oven'.

So the semiconductor material we are more concerned about is not the actual material itself (silicon or germanium), but the material after it has been doped. Furthermore, a piece of doped silicon or germanium on its own is not particularly useful either, and most semiconductor devices have at least one piece of N type and one piece of P type semiconductor joined, to form a *junction*.

So what we are really interested in at this stage is the effect of *combining* the N type and P type semiconductor materials.

The PN junction

When a piece of N and a piece of P type semiconductor material are joined, a PN junction is formed. And as it turns out, this junction behaves as a diode, as shown in Fig.2(a). End of story!

Not really, although it is basically that simple. However, we need to look more closely at some of the electrical characteristics of the PN junction to be able to appreciate what a semiconductor diode is all about.

There are two operating conditions for a PN junction – forward bias and reverse bias, shown respectively in Fig.2(b) and (c). When forward biased, current flows through the junction, and when reverse biased, current doesn't (or shouldn't) flow. Let's look at the forward biased condition first.

As already mentioned, bias refers to the DC conditions. Forward bias for a *silicon* PN junction means a voltage of approximately 0.6V DC across the junction, applied as shown in Fig.2(b). However current will start flowing if the forward voltage is less than 0.6V, and as the current increases the forward voltage drop will increase to as much as 1V or more. In other words, the forward voltage across a diode is not fixed to 0.6V, and can vary from 0.3V to over 1V, depending on the temperature and the amount of current flowing through the junction. This is depicted in the graph of Fig.2(d).

Under forward bias conditions, the current that flows is usually referred to as the *forward* current. By Ohm's law, you would expect that as the forward current rises the voltage drop across the junction should also rise. It does, but not in the linear way Ohm's law says it should. For example, if the voltage drop across the junction is 0.6V for a current of 10mA, Ohm's law says it will be 6V for a current of 100mA. In fact, the voltage drop will probably only be around 0.7V, suggesting either that Ohm's law is wrong, or that something else is going on inside the junction.

What actually happens is that the resistance of the junction drops as the current increases. This resistance is referred to as a *dynamic* resistance, and is a property of any PN junction. There is also a certain value of fixed resistance, called the *bulk* resistance, but this is generally quite small.

When the PN junction is reverse biased, then theoretically no current flows. However there is usually a small amount of *leakage* current, although it is generally in the order of a few microamps. If the reverse voltage is increased, eventually the junction will be destroyed. This point is known as *breakdown*, and here the reverse current rises to a value limited only by the rest of the circuit as shown by the graph of Fig.2(d).

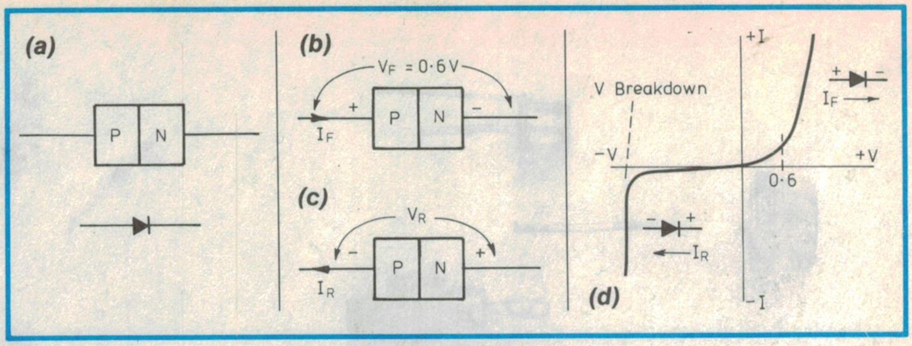


Fig.2: (a) the PN junction and how it relates to the diode symbol; (b) a forward voltage of around 0.6V (for silicon) is required for forward current to flow; (c) if the bias is reversed, a small reverse or leakage current flows; (d) a graph of current for both forward and reverse bias.

The above description refers to the silicon PN junction (or silicon diode). The germanium PN junction is slightly different in that it has a lower forward voltage (usually around 0.3V) and a higher reverse leakage current. The earliest semiconductor devices were germanium types, but silicon is generally used in today's semiconductors.

Diode behaviour

As shown in the photographs, diodes come in various shapes and sizes, but they can usually be grouped into the categories of signal diodes or power diodes. Whatever their category, there are a few important characteristics about diodes that dictate how they can be used in a circuit.

The first is the forward current the diode can handle. A power diode can usually pass a forward current of 1A or more, while signal diodes are generally only capable of 100mA or so. Exceeding the forward current will cause the diode to overheat and eventually fail.

The next important characteristic is the *peak inverse voltage* (PIV) the diode can withstand. The PIV rating is the maximum value of reverse bias the diode can withstand safely, before breakdown occurs. This rating depends on the construction of the diode and can vary from 50V to voltages over a several kilovolts. Most power diodes are rated at around 400V to 1kV and signal diodes rarely exceed 100V. The so-called 'stick rectifier' used in some TV sets consists of many diodes connected in series, encapsulated in a ceramic tube. This type of diode can withstand reverse voltages of over 25kV.

The reverse current of a diode is not always an important consideration, but can be a factor with signal diodes in particular. Reverse current is usually specified as the value of current that will flow when the maximum rated reverse voltage is applied across the diode. Most silicon power diodes have a reverse current of 5uA or less, although some heavy duty types may have a leakage of 1mA or more. Signal diodes generally have a lower reverse current than

TABLE 1: Typical diode characteristics

TYPE NO	PURPOSE	PIV (V)	I_F	I_R	V_F at I_F
0A91	point contact signal diode	90	50mA	180uA	1.9 @ 10mA
1N914A	silicon, small signal switch	75	75mA	5uA	1 @ 10mA
1N4148	silicon, small signal switch	75	200mA	25nA	1 @ 10mA
1N4448	silicon, small signal switch	75	300mA	25nA	1 @ 100mA
IN4001	rectifier, low voltage	50	1A	5uA	1.1 @ 1A
IN4002	rectifier, low voltage	100	1A	5uA	1.1 @ 1A
IN4004	general purpose rectifier	400	1A	5uA	1.1 @ 1A
IN4007	general purpose rectifier	1000	1A	200nA	1.1 @ 1A
IN5408	3 amp rectifier	1000	3A	5uA	1.1 @ 3A

the power types, and the popular 1N4148 signal diode has a reverse current of 25nA.

The forward voltage drop across a diode is nominally stated as 0.6V for silicon, but this value will rise to around 1V at the full rated forward current. Germanium diodes are not generally available, particularly as power diodes, but 'point contact' germanium diodes are still manufactured. These are often used in radio receivers to 'detect' the audio information transmitted by the station. The point contact diode has a fairly low forward voltage when the forward current is low, but because of the small size of the diode element, this voltage can rise to over 2V at the full rated current.

Table 1 summarises diode characteristics by listing the specifications for some of the more popular diode types. The specifications given are 'worse case' and a diode rated at 100V PIV will probably still function satisfactorily at 150V. Also, the leakage current values are guaranteed maximum values, and typical leakage currents will usually be less than those given.

Other diodes

We said at the start that the diode is a most useful device. Technology has pushed the diode principle into applications that are quite wide ranging and we'll briefly examine a few of these.

Perhaps the most well known application of a diode other than as a unidirectional current carrying device is the light emitting diode (LED). Light, in all its forms, is produced by electrons or atoms moving between so-called 'energy levels', as anyone versed in quantum physics will know. To make an atom change from a lower energy level to a higher one requires some form of external excitation, such as heat or with an electric current.

Once raised to a higher energy level, the atom will attempt to return to its normal energy level, on the way dissipating the gained energy usually in the form of heat. But under certain circumstances, the energy released will be photons of light. Silicon or germanium diodes release heat rather than light, and most LEDs are produced with gallium arsenide phosphide (GaAsP) or gallium phosphide (GaP). The GaAsP (or GaAs) type emits red light, and the GaP type give out green to yellow light. Blue LEDs are also manufactured, and use silicon carbide as the active material.

A typical red LED requires around 10mA of forward current, at a forward

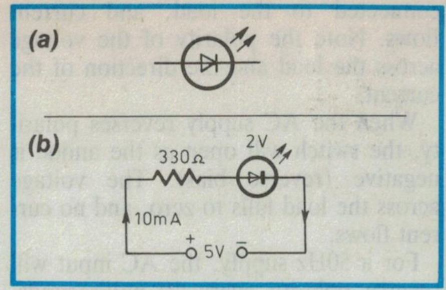


Fig.3: (a) the symbol for a LED; and (b) how a series 330 ohm resistor can be used to power a LED from 5V DC.

voltage of 2V. They usually have a very low PIV, typically of 5V or so. The symbol of a LED is shown in Fig.3, along with a circuit showing how a LED can be driven from a 5V power supply. We will have more to say about LEDs when we discuss opto-electronic devices in a future chapter.

On the subject of opto-electronic devices, a diode can be used to *detect* light. In the presence of light, the reverse current of a PN junction will increase, and *photodiodes* are constructed so that the PN junction is close to a lens fitted to the body of the diode. Again more on the photodiode in a future chapter.

Another property of a diode that is very useful is that the *capacitance* of the junction will change as the reverse bias

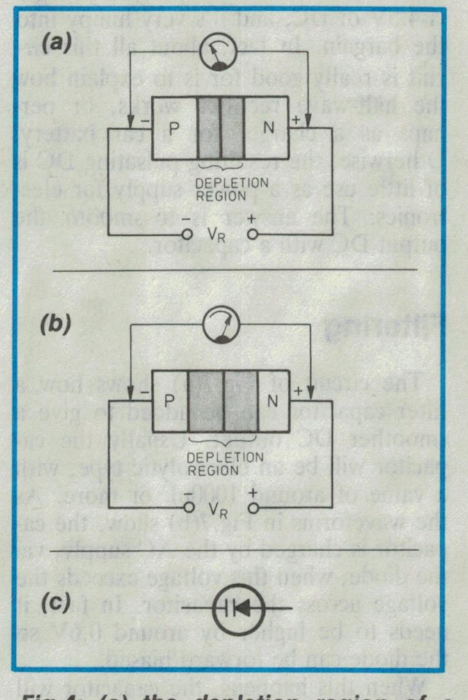


Fig.4: (a) the depletion region of a diode with a small value of reverse bias; (b) increasing the reverse voltage makes the depletion region wider, lowering the capacitance of the junction. The symbol of a varicap diode is shown in (c).

is varied. When a PN junction is formed, the carriers in both junctions combine to form a *depletion* region. It is this section of the junction that causes the 0.6V (for silicon) *barrier* voltage that must be overcome for current to flow.

When a reverse voltage is applied this region widens, as shown in Fig.4. In effect, the depletion region is an insulator, and the N and the P type semiconductors are the plates of a capacitor. The higher the reverse voltage the lower the capacitance, giving a DC-controlled variable capacitor.

Although all diodes have this characteristic, special diodes, called *varicap* or *varactor* diodes are made specifically for the purpose, such as the BA102 device. These diodes are commonly used in TV and radio tuners, and allow tuning to be achieved with a variable DC voltage.

There are many other types of diodes, including special high frequency types, those that have a very fast switching speed and others with specific characteristics. The Schottky diode is worth mentioning as although specialised, it has considerable application in digital integrated circuits.

The Schottky diode (or *hot carrier* diode) is formed by joining a piece of lightly doped N-type silicon and a piece of metal, such as gold, silver or platinum. The Schottky diode is therefore not a PN junction, but a metal-to-semiconductor junction. The main feature of a Schottky diode is that it can switch from conduction to non-conduction very quickly, making it ideal as a high speed switch, and it also has a lower forward voltage drop of around 0.2V. The symbol and construction of the Schottky diode is shown in Fig.5.

The *zener* diode is another special type of diode. This diode has the unique property of being able to pass current in the reverse direction without the diode being destroyed. As the zener is such an important device, we will reserve it for future discussion.

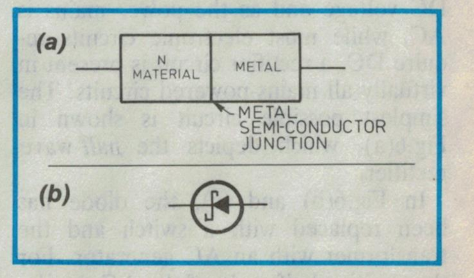


Fig.5: The Schottky diode is a special high speed diode, constructed as shown in (a). The symbol is depicted in (b).

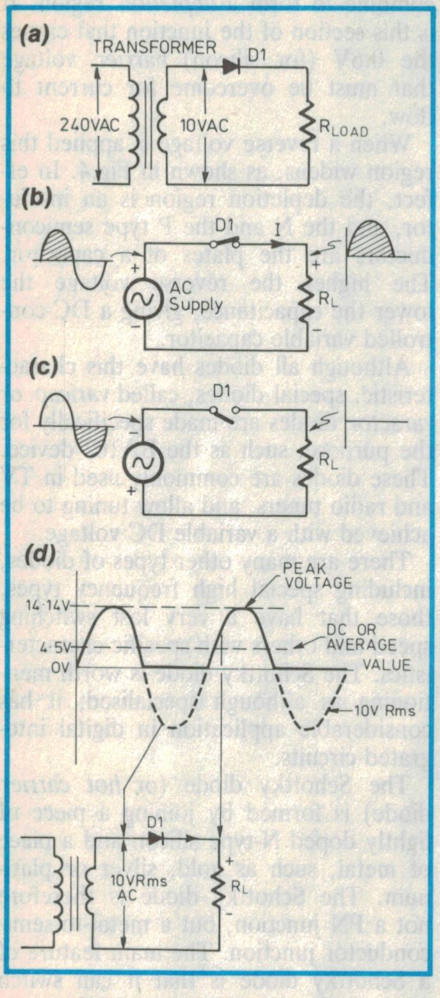


Fig.6: A basic half-wave rectifier circuit is shown in (a), while (b) and (c) show how the diode behaves as a switch for each half of the input cycle. The DC output voltage across the load is depicted in (d), which for the values given equals 4.5V DC.

Rectification

The most fundamental role of the diode is as a *rectifier*. This application refers to converting an AC voltage to a DC voltage and as the power mains is AC, while most electronic circuits require DC, a rectifier circuit is present in virtually all mains-powered circuits. The simplest possible circuit is shown in Fig.6(a), which depicts the *half-wave* rectifier.

In Fig.6(b) and (c), the diode has been replaced with a switch and the transformer with an AC generator. For the positive half cycle of the AC supply, as shown in (b), the switch representing the diode will close, as the anode is positive. The AC supply is therefore connected to the load, and current flows. Note the polarity of the voltage across the load and the direction of the current.

When the AC supply reverses polarity, the switch will open as the anode is negative (reverse bias). The voltage across the load falls to zero, and no current flows.

For a 50Hz supply, the AC input will reverse polarity every 10 milliseconds, and the switch representing the diode will open and close at this rate, giving the waveform across the load as shown in Fig.6(d). The result is a DC voltage, as it doesn't change polarity.

An important point to note is that, for the connections shown in the circuit, the output DC is positive. You may be wondering why, as we've being saying all along that the polarity at the cathode should be negative. In fact, the anode will be *more* positive (by at least 0.6V) than the cathode. Just think of the diode as a switch, but with a 0.6V drop across it when closed.

For a 10V RMS AC input, the values shown on the waveforms of Fig.6(d) will apply. The peak value of the waveform equals the RMS value multiplied by 1.414 (square root of 2), and the average value (or DC value) of the waveform across the load is found by dividing the peak value by 3.14 (Vp/π).

So for a 10V RMS input, all you get is 4.5V of DC, and it's very lumpy into the bargain. In fact, about all this circuit is really good for is to explain how the half-wave rectifier works, or perhaps as a charger for a car battery. Otherwise, the resulting pulsating DC is of little use as a power supply for electronics. The answer is to *smooth* the output DC with a capacitor.

Filtering

The circuit of Fig.7(a) shows how a filter capacitor can be added to give a smoother DC output. Usually the capacitor will be an electrolytic type, with a value of around 1000uF or more. As the waveforms in Fig.7(b) show, the capacitor is charged by the AC supply, via the diode, when this voltage exceeds the voltage across the capacitor. In fact, it needs to be higher by around 0.6V so the diode can be forward biased.

When this happens, the capacitor will be charged from the supply, shown shaded in the diagram. When the AC input voltage falls, the diode will be reverse biased, and the capacitor will discharge through the load, in effect supplying the load current. Thus, the capacitor is charged with large bursts of current that last for a short time, and discharged over a longer period by the load current.

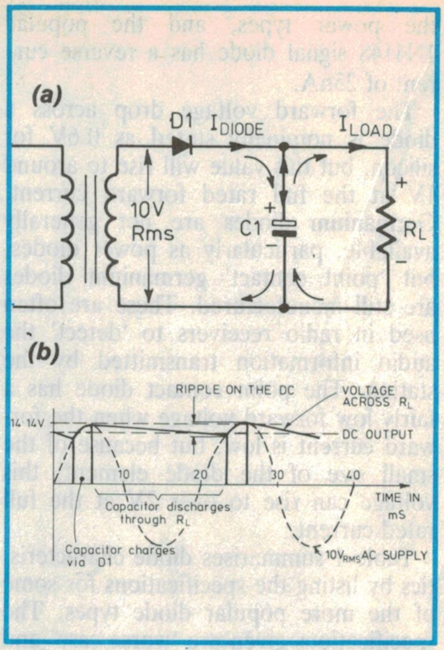
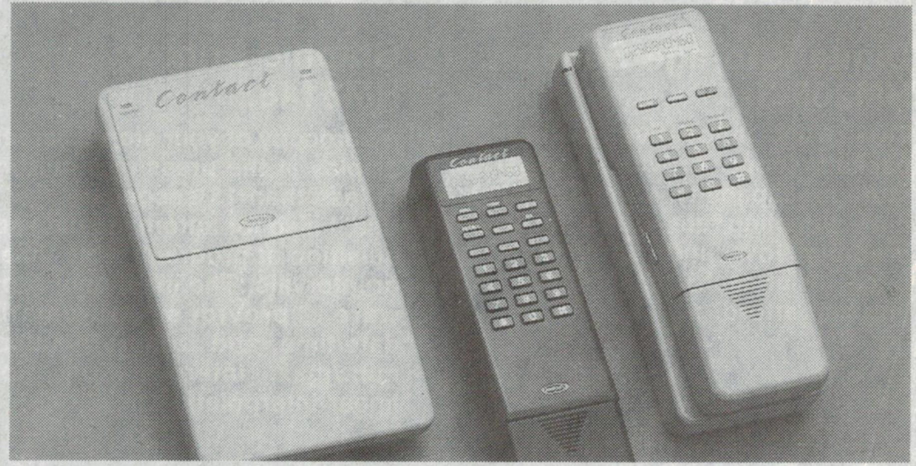


Fig.7: By adding a capacitor to the half-wave rectifier as shown in (a), a smoother and higher value of DC output voltage is obtained (b). The time durations are for a 50Hz AC supply.

The resulting output voltage is therefore much smoother, and has a higher DC value. In fact, if there is no ripple, the DC output voltage will virtually equal the peak value of the AC input. If the input AC voltage is 10V RMS, as before, the DC output can be as high as 14V or so. Not a bad improvement, and now the DC voltage is relatively smooth into the bargain.

A problem with this circuit is that the charge current, (which is also the current through the diode) is a series of high value, short duration pulses. If the load current is 1A, the peak value of the diode current will be over 10A, which is quite a strain on the diode and the transformer. Also, because of the relatively long time interval between charge pulses, the voltage across the capacitor will drop quite a lot between charges if the load current is high. This will give a fairly high value of *ripple* on the output waveform, and this circuit is generally only used when the load current is low (10mA or so).

In the next chapter, we will continue with the power supply, and describe circuits that have two, and even four, diodes connected as a rectifier that can drive loads of over 1A.



RACAL UNVEILS CT-2 PHONE

The Orbitel CT-2 cordless telephone has been unveiled by its Australian representative, Racal Electronics. The small lightweight cordless phones, known as 'Contact', operate when the user is within the vicinity of strategically positioned 'telepoint' receiving stations.

Austel has recommended that up to four telepoint licences be awarded, including one to Telecom Australia, based on the CT-2 Common Air Interface (CAI) standard. A final decision is expected by the end of 1990.

Racal Electronics' General Manager, Phil Taylor, said the UK based Orbitel's CT-2 CAI equipment is believed to be the first operational telepoint system to be demonstrated in Australia. CAI allows the CT-2 owner to use the telepoint facilities of all operators in the market.

He said that CT-2 phones would go on sale when the telepoint system is established in Australia early next year. The system is currently operating in London.

AUSSIE PHONE ENCRYPTOR

A telephone security encryptor – placed between the phone and the line – has been released by Australia's leading encryption company, GSA Randata.

Compatible with most phones, the GSA1401 locks into secure mode at the simple touch of a button. The security is based on a proprietary multi-dimensional encryption technique which is totally asynchronous and requires only 3kHz of bandwidth. The unit is almost totally transparent to the network and will function reliably on any communication path.

The cryptographic strength is obtained by using the company's accepted proprietary algorithms and a very sophisticated key management system means that the unit can be configured for all types of operations.

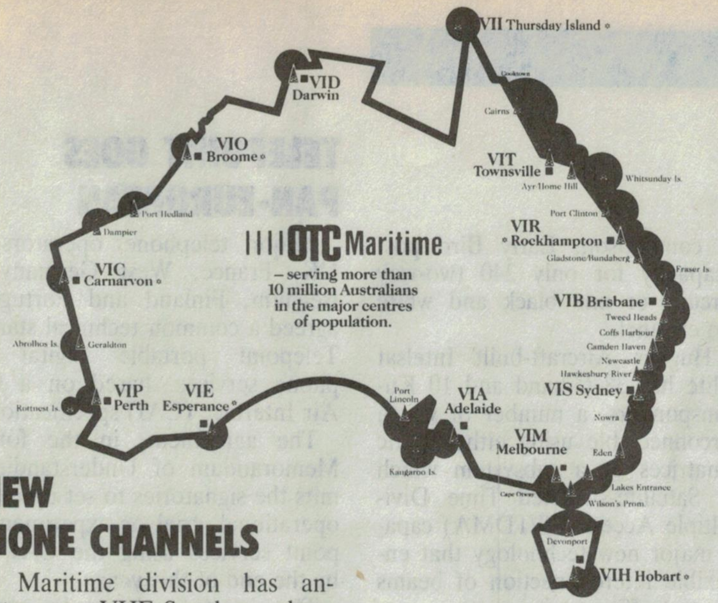
GSA Randata Managing Director, Geoff Ross, said the encryptor was based on proprietary technology developed in the company's Melbourne research laboratory.

For further information contact GSA Randata, phone (03) 822 7858.

PACIFIC RIM NET AGREEMENT SIGNED

An agreement which will see the installation of the last link of a new high security/high capacity telecommunictions network to circle the Pacific Ocean has been announced in Maui in Hawaii. Signatories to the agreement are Australia's worldwide communcations company OTC Limited, Kokusai Denshin Denwa (KDD) of Japan and AT&T of the United States.

In memorandum of understanding between the international telecommuncations carriers from Australia, Japan and the United States sees the completion of the optical fibre network which takes in Tasman 2, (the cable which runs from Australia to New Zealand) PacRimWest (Australia to Guam) and PacRimEast (New Zealand to Hawaii) as well as cables from Hawaii to the US mainland and from the mainland to Japan.



TEN NEW SEAPHONE CHANNELS

OTC's Maritime division has announced ten new VHF Seaphone channels in NSW, Queensland and West Australia as part of its ongoing nationwide expansion program.

In NSW, the new services include Channel 88 to expand Sydney's busy Seaphone services and Channel 62 at Camden Haven – providing for the first time Seaphone coverage north from Forster/Tuncurry to Smoky Cape and 100km seaward.

In Queensland, a new Seaphone channel is now operating at Fraser Island (Channel 62) covering popular Hervey Bay and south to Noosa Heads. Once the effects of recent flooding are overcome, the interim service at Gladstone (Channel 27) will be relocated to a superior site to provide greater coverage. In Brisbane, a third Seaphone channel (Channel 28) has been introduced to meet growing demand.

For technical reasons, the recently established Seaphone facility at Mount Inkerman near Ayr in northern Queensland (formerly Channel 2) is now redesignated Channel 60 and extends Seaphone coverage from Townsville and throughout the Burdekin region south to Bowen and 80km seaward.

In West Australia, new Seaphone facilities are now operating at Broome (Channel 26), Port Hedland (Channel 27) and Dampier (Channel 23), each controlled remotely by OTC's Maritime Communications Station in Darwin. Similarly, Carnarvon's new Seaphone Channel 26 is controlled remotely through OTC in Perth. With the opening of Channel 60 on Rottnest Island, Perth now has three Seaphone channels.

Having completed its current Seaphone expansion program in West Australia, OTC is preparing to further extend VHF services on the eastern seaboard and particularly in Tasmania and South Australia.

HANNOVER FAIR GOES FOR CT-3

The Hannover Fair selected the Ericsson CT-3 cordless telephone system for its telecommunications network, to give both exhibitors and visitors access to the most modern cordless telephone system technology available. CT-3 was chosen because it enables total mobility within the network and includes such features as full automatic system roaming, seamless in-call handover and full speech encryption for absolute privacy of conversation.

"We studied carefully all of the alternatives which are now available, and came to the conclusion that Ericsson's CT-3 concept is the only one that enabled us to implement a professional network of the type we require to satisfy the demands of our customers", said Mr Weinberg, Manager of the Hannover Fair.

The CT-3 network will begin with a test phase during 1991 with system implementation already starting this year. It will be coupled to the existing Siemens Hicom 300 PABX and will include Ericsson's modern MD110 digital PABX switch for the advanced roaming and networking features. It is expected that when the network is completed, it will have to cope with more than 10,000 subscribers as users discover the convenience of the personal telephone. The CT-3 portable handset, which weighs only 195 grams, offers six hours of talktime or 60 hours of standby, which is enough to cover almost a full week of continuous use.

EDUCATIONAL DATA NETWORKS

Pegasus Networks is the representative in Australia of the Association for Progressive Communication (USA) which brings together a large number of networks, organisations and individuals participating in peace, environment, computer technology, education, human rights and social change issues.

Currently there are over 800 computer conferences talking place on the network, enabling people from within Australia and around the world to particpate in and follow discussions, research and developments in a vast array of subjects around the abovementioned issued.

In addition to conferencing, Pegasus also offers an extensive electronic mail (E-mail) service within APC and provides gateways to many other networks and databases.

The Network uses a communication technology based on a telephone modem connected to your personal computer and is compatible with almost all models of personal computers available in Australia.

Further details from Pegasus Networks, PO Box 424, Byron Bay 2481 or phone (066) 85 6789.

SATELLITE LINK FOR CUSTOMS INFO

A Soviet ship, sailing between Leningrad and Stockholm, has demonstrated how ships can clear customs using satellites instead of paperwork. The 12,281-ton luxurious Soviet ferry *Ilich* sent customs information using the Inmarsat satellite system to Swedish port authorities, paving the way for the 'paperless' clearance of ships in future.

Owned by the Baltic Shipping Company and carrying both cargo and passengers, *Ilich* is the first ship ever to have used satellite communications to send 'live' customs information between computers on ship and shore. The transmission of information to the Swedish Customs Regional Headquarters in Stockholm took less than two minutes. Such transmissions will enable port authorities to receive advance information and clear the ship long before docking in.

The only equipment needed was a portable computer, a modem and an Inmarsat-A satellite communications terminal. The software package was developed by City Systems, a London-based firm at a cost of approximately $8500.

THIRD INTELSAT VI SATELLITE LAUNCHED

The third of the Intelsat VI series of satellites – the F-4 – was successfully launched on June 23 from Cape Canaveral Air Force Station in Florida. A Commercial Titan launched the F-4 into a low-altitude 'parking' orbit with a perigee altitude of almost 100 nautical miles and an apogee altitude of just over 200 nautical miles.

The F-4 will be placed in the orbital location of 332.5° E and is scheduled to become operational early in September. This orbital location is the same position held by Intelsat's first satellite, Early Bird. It will join the first Intelsat VI (F-2) to provide unrivalled capacity for advanced voice, video and data services to customers in the Atlantic Ocean Region, from the Americas in the west to Europe and Africa in the east.

Using advanced digital circuit multiplication techniques, each Intelsat VI can carry as many as 120,000 telephone calls and three colour television channels. In comparison, Early Bird possessed capacity for only 240 two-way voice circuits or one black and white television channel.

Each Hughes Aircraft-built Intelsat VI satellite has 38 C-band and 10 Ku-band transponders, a number of which are interconnectable using either static switch matrices or a subsystem which provides Satellite-switched Time Division Multiple Access (SS/TDMA) capability, a major new technology that enables flexible interconnection of beams according to traffic requirements.

The F-4, like others of the VI series, is one of the world's largest commercial communications satellites. Stowed for launch, it measured almost 5.4 metres tall; after deployment of its telescoping solar panels and five communications antennas, it measures nearly 11.8 metres. The F-4's initial mass in geostationary orbit will be over 2546.2kg or 2.5 tonnes.

TELEPOINT GOES PAN-EUROPEAN

Major telephone operators in the UK, France, West Germany, Spain, Belgium, Finland and Portugal, have agreed a common technical standard for Telepoint portable digital cordless phone services, based on a Common Air Interface (CAI) specification.

The agreement, in the form of a Memorandum of Understanding, commits the signatories to set up either fully operational, trial or experimental Telepoint services using the CAI standard by the end of this year.

The signatories have also agreed that by 1993, the aim is to have Telepoint services in all major cities, main railway stations and main airports. In the UK, three operators already offer Telepoint services from several hundred based stations and by the end of this year, it is expected that there will be several thousand base stations installed.

Telepoint operates in the 864-868MHz UHF band. EA

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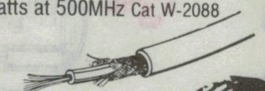

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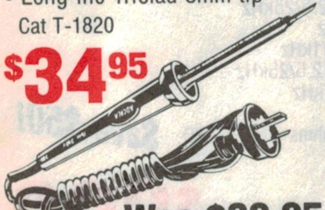

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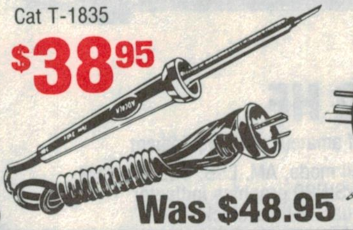

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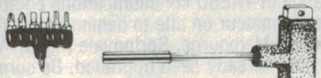

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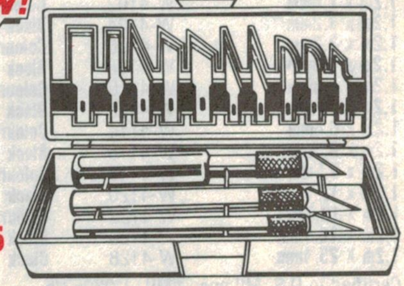

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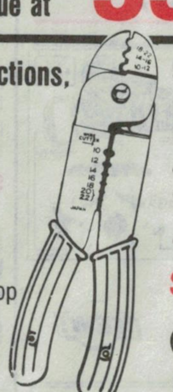

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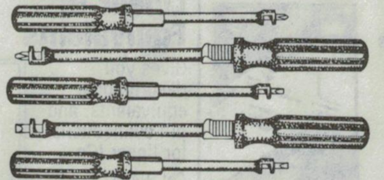

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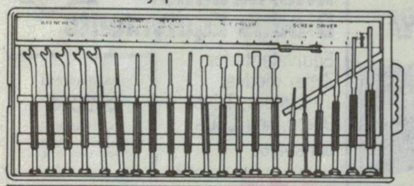

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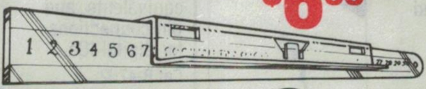

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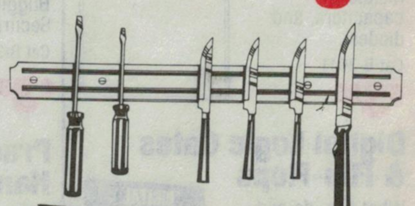

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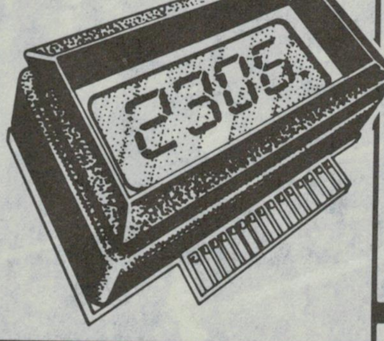

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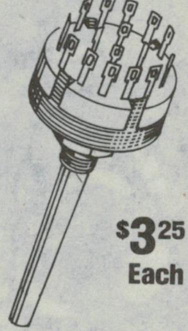

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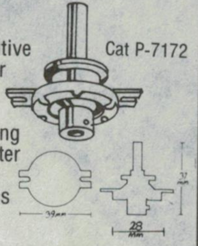

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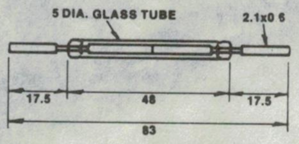

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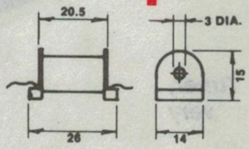

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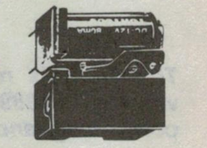

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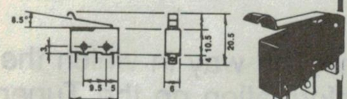

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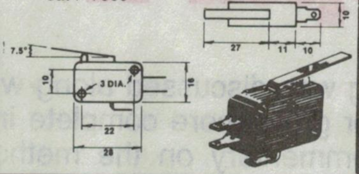

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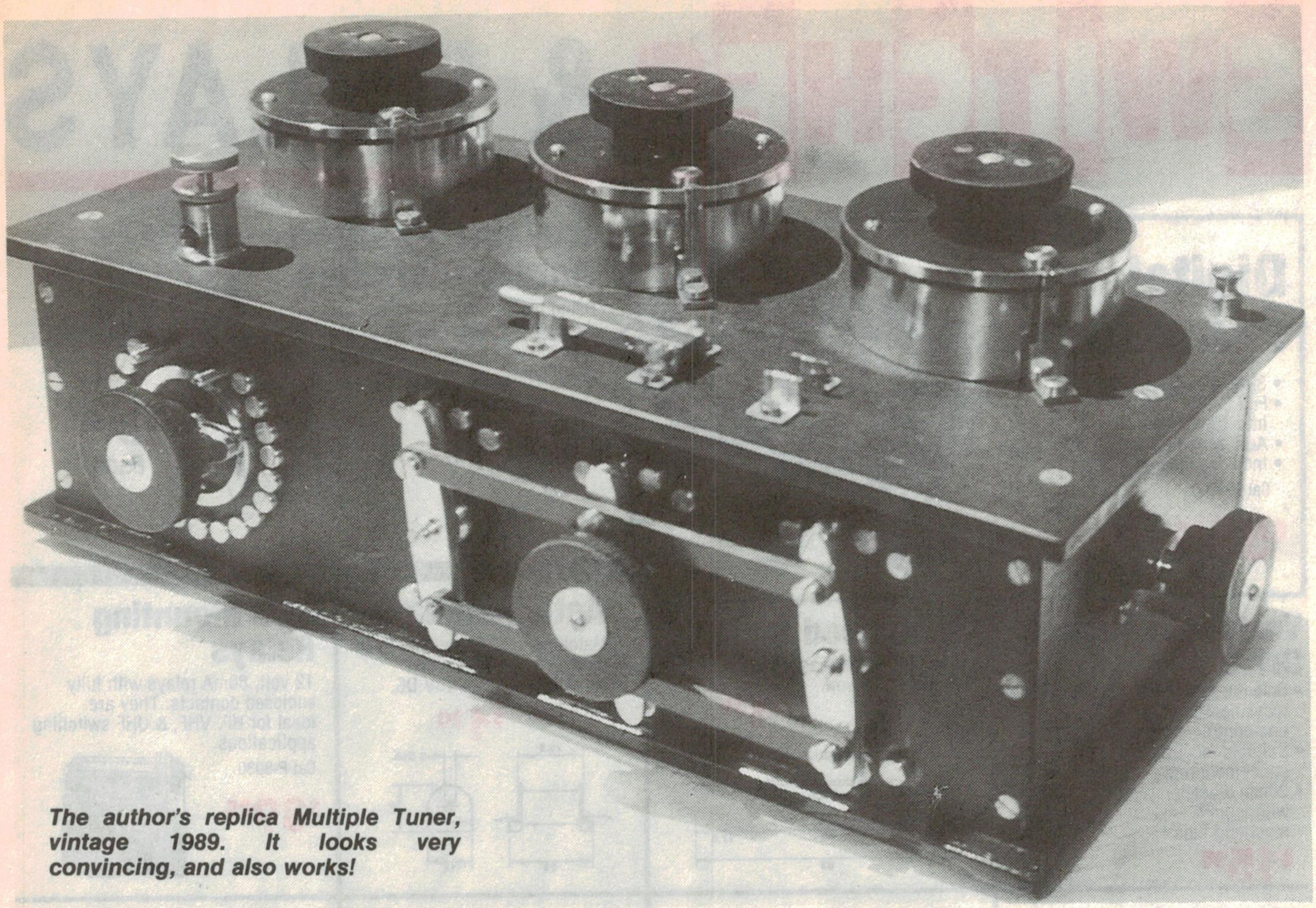


The author's replica Multiple Tuner, vintage 1989. It looks very convincing, and also works!

Syntony & Spark - 2

In the first of these articles, the need for tuning was discussed along with the way in which the Multiple Tuner was developed. Here the author gives more complete information on the Tuner itself, including dimensions and a detailed commentary on the method of construction. This should allow any intending constructor to replicate this quite complex but vital element of early wireless communication.

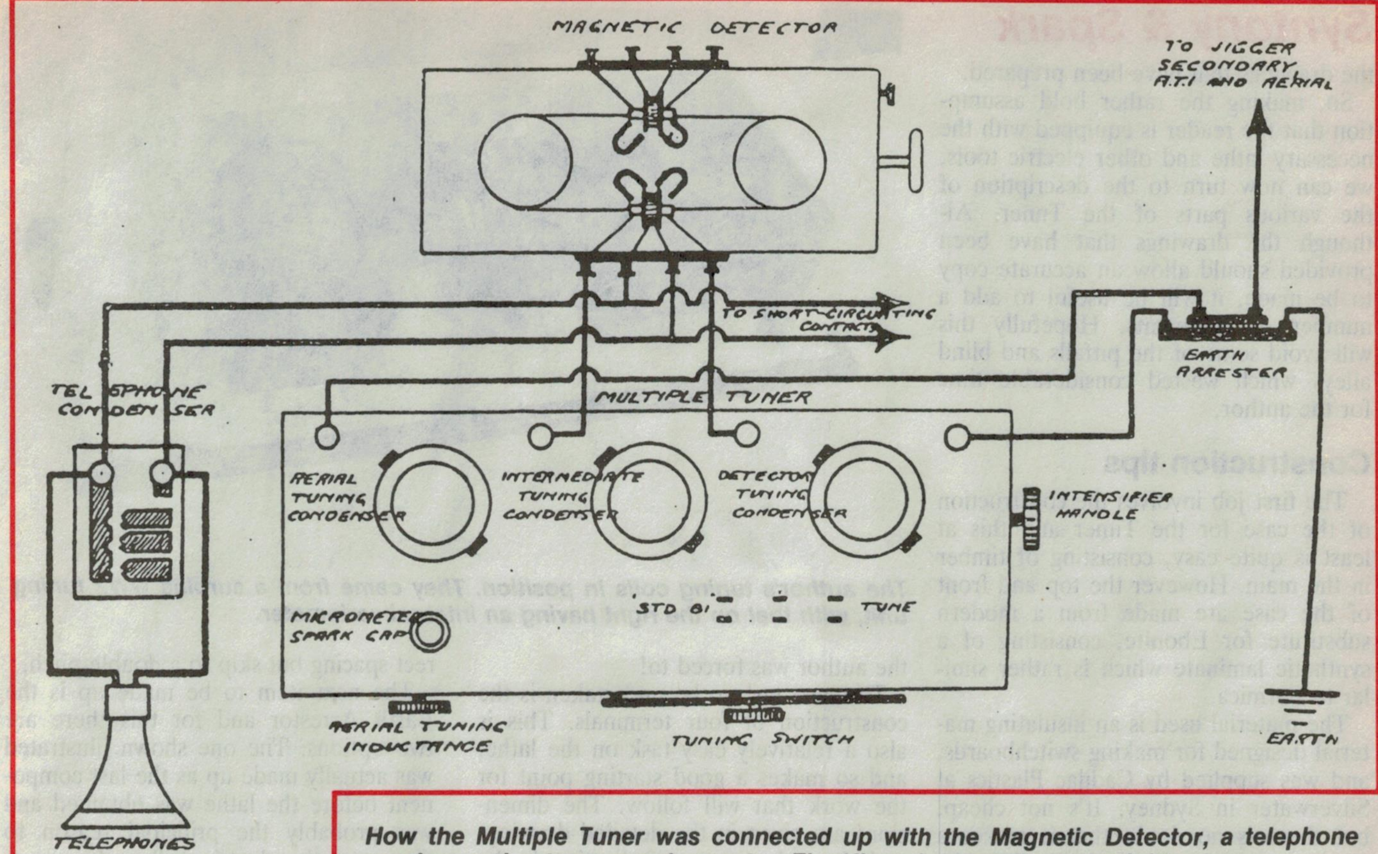
by PETER R. JENSEN, VK2AQJ

It probably needs to be said at the beginning of this description of the construction of the Multiple Tuner, that this is not a project to be tackled lightly. Where other projects in this series, concerning replicas of the elements of early wireless gear, have been constructed with the aid of an electric drill and other hand tools, with the Tuner a major change was required.

It may not be immediately apparent from the illustrations that accompany this article, but it is nevertheless true that the work involved probably cannot be successfully undertaken without the help of a small lathe. This is what lies squarely at the heart of this generally faithful reproduction, and it isn't really feasible to replicate some of the parts of the tuner with only an electric drill.

No doubt any small bench lathe would be adequate, provided that it will hold work up to about 100mm in diameter. As to the skill involved in driving such a machine, it may well be necessary to do as the author did and take one's self off to the local CAE for a couple of terms to learn the rudiments of lathe work. Not that such a stint should represent any great hardship, if you like to work with your hands.

Another departure, as compared with earlier projects described by the author, is the preparation of properly drafted illustrations, set up accurately to scale. Previously, freehand sketches have been considered clear enough, when supplemented with written dimensions, to allow the devices being described to be accurately reproduced. However in this instance, the range of parts and their location and dimensions are critical if a

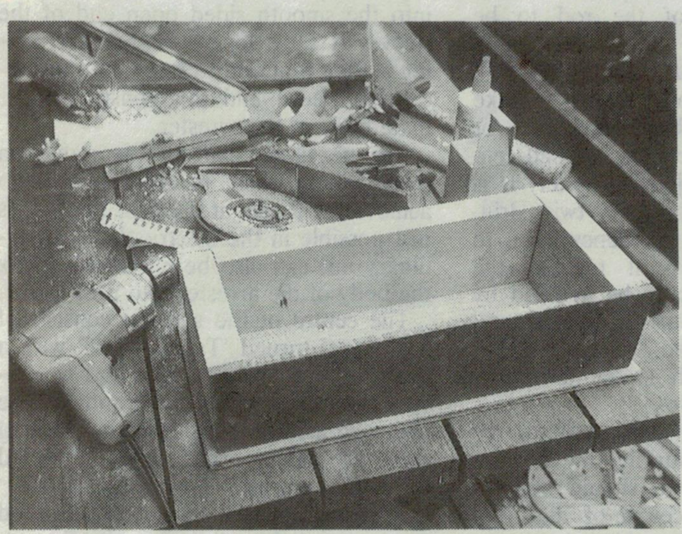


How the Multiple Tuner was connected up with the Magnetic Detector, a telephone receiver and antenna spark arrestor. The 'Jigger' connects at top right.

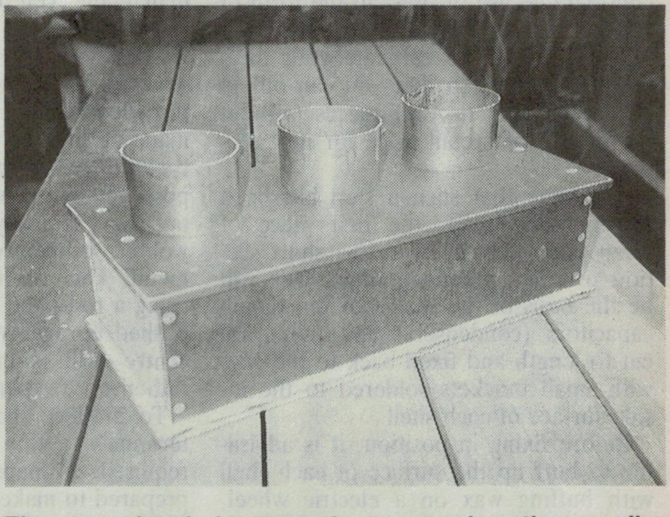
true replica is to be produced and not just an approximation.

It should be mentioned here that another major factor in assuring the success of the replica to be described, was the generous assistance of the Museum of the State of Victoria. During a visit to Melbourne two years ago, an opportunity was taken to explore the Museum. Apart from examing the Amateur Radio Station at the Museum and meeting the volunteer operator, the author noticed an example of the Multiple Tuner nestling coyly amongst a variety of other items in a display designed to celebrate the forthcoming Bicentennary.

A number of colour photographs were taken, to supplement those that had been made in Chelmsford (UK) at the Marconi archives some years ago. Later a discussion with one of the Curators led to several letters being exchanged and ultimately the Museum was to generously provide a series of black and white photographs – taken so as to give accurate plan and elevational information at a defined scale. From these photographs dimensions could be scaled off quite accurately using perspective geometry, and this has been the basis of



A shot taken when the author was part-way through assembling the box for the replica Multiple Tuner. This part requires only the use of basic hand tools, as shown.



The completed box, ready to receive the smaller components. The top and front are made from synthetic laminate, similar to Ebonite, while the three tuning capacitor shells are of 100mm brass plumbing tube.

the drawings that have been prepared.

So, making the rather bold assumption that the reader is equipped with the necessary lathe and other electric tools, we can now turn to the description of the various parts of the Tuner. Although the drawings that have been provided should allow an accurate copy to be made, it will be useful to add a number of comments. Hopefully this will avoid some of the pitfalls and blind alleys which wasted considerable time for the author.

Construction tips

The first job involves the construction of the case for the Tuner and this at least is quite easy, consisting of timber in the main. However the top and front of the case are made from a modern substitute for Ebonite, consisting of a synthetic laminate which is rather similar to Formica.

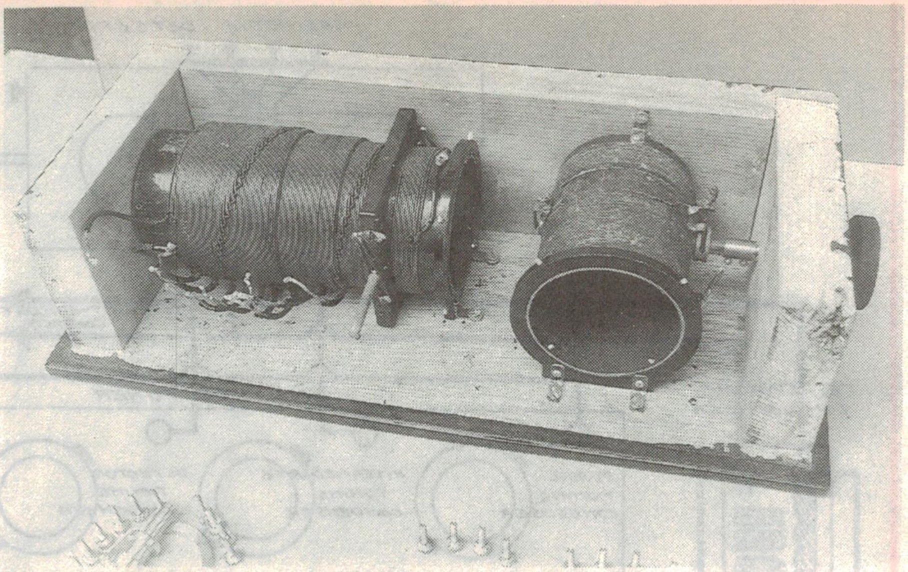
The material used is an insulating material designed for making switchboards, and was supplied by Cadilac Plastics at Silverwater in Sydney. It's not cheap, but there is no doubt that it makes a most appropriate substitute for the genuine article, being of a similar colour and consistency to Ebonite. It is extremely hard and the best thing to cut it with turned out to be a jigsaw with a metal cutting blade.

As the illustrations show, the box is quite uncomplicated and is put together with nails and PVC glue (Aquadhere) where not visible. The top and front, however, are screwed into position with brass screws.

From this stage on, there will be a considerable use of brass in the form of rod, sheet and tube. For this reason it may be as well to cultivate your local scrap merchant, so that you can obtain the necessary bits and pieces without paying the full retail price for new sections.

Assuming that such a step has been accomplished then, the first piece of scrap that you will need is a short section of brass plumbing tube. This will be the basis of the shells for the tuning capacitors (condensers) and these are cut to length and fixed back to the case with small brackets soldered to the inside surface of each shell.

Before fixing in position, it is advisable to buff up the surface of each shell with buffing wax on a electric wheel, and seal the polished surface with Wattyl 'Acrylac'. It's annoying to have to take everything to pieces right at the end, to do the polishing and sealing, as the author was forced to!



The author's tuning coils in position. They came from a surplus WW2 tuning unit, with that on the right having an internal variometer.

The next task to be undertaken is the construction of four terminals. This is also a relatively easy task on the lathe, and so makes a good starting point for the work that will follow. The dimensions are given in the detailed drawings and the only minor conplication is the need to cut re-entrant grooves in both top and sides of the actual terminal top.

It is probably best to grind one end of the normal cutting tool to a shape that is usually referred to as a 'round nosed roughing tool'. This is a symetrical tool which can be used to cut on both sides of a reentrant groove. For cutting brass the top of the tool is left flat, rather than being cut in at an angle as would be the case for mild steel. The tool height should be carefully set so as to match the centre of the rod to be turned.

The terminals and their collars will have to be drilled and tapped to take threaded rods, either purchased or made up and for accuracy, a small centre drill makes the job far easier. It is possible to use an ordinary twist drill, but there is always a tendency for it to wobble off-centre as it touches the metal. This can usually be avoided by using a rod fixed in the tool holder and pushed up against the drill bit, but the centre drill is much easier to use if rather more expensive.

To produce the knurling edge to the terminals, a fine knurling tool will be required. Perhaps you should also be prepared to make a couple of 'duds' before a perfect finish is achieved. Do not be in too much of a hurry with this step or wind the tool against the metal too hard, or it will not cut teeth at the correct spacing but skip to a double pitch.

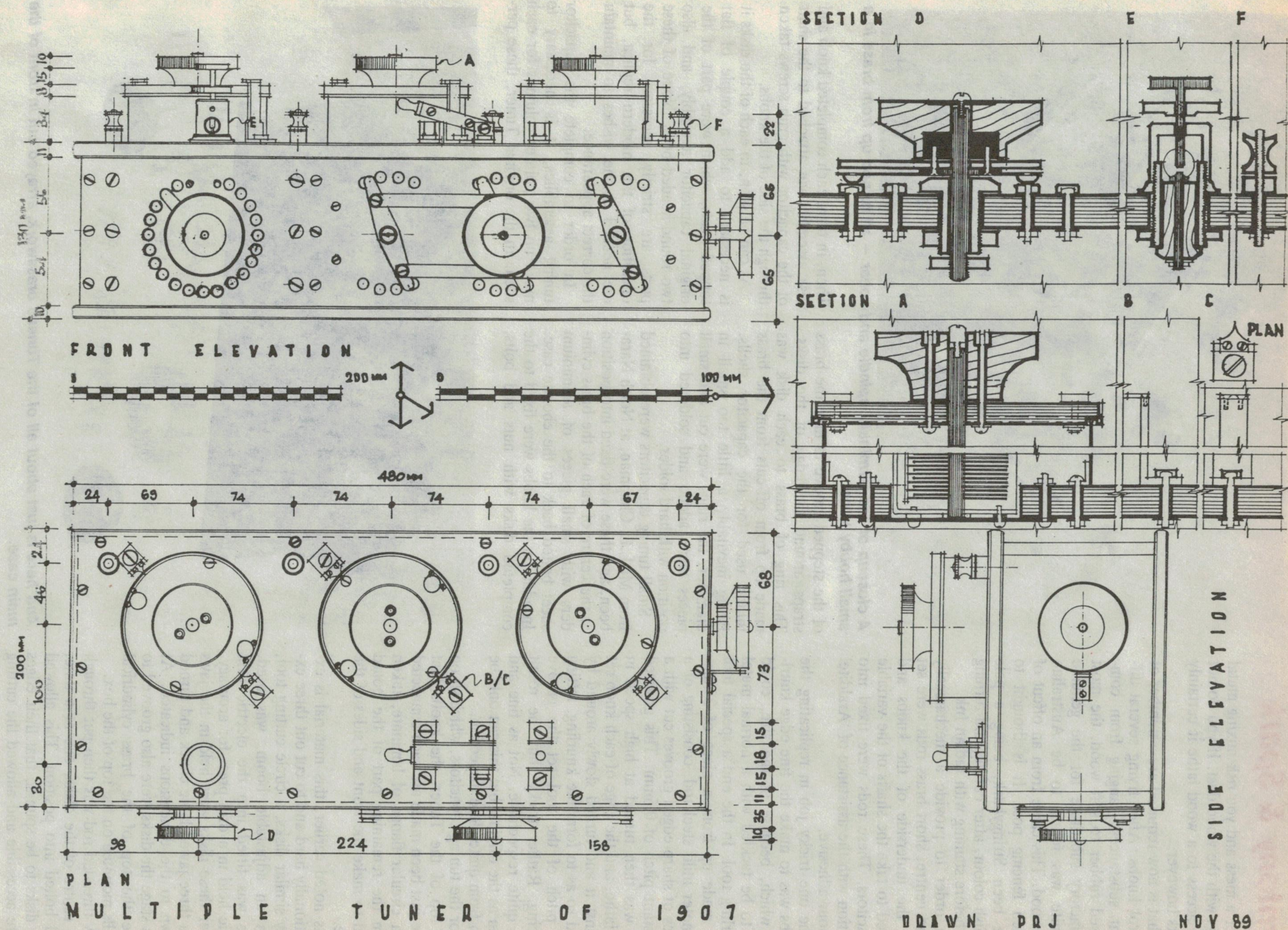
The next item to be made up is the Earth Arrestor and for this there are two options. The one shown illustrated was actually made up as the last component before the lathe was obtained and was probably the principal reason to give away the electric drill as the means of spinning brass sections. With a lathe available, clearly the shapes required could be cut directly from rod and threaded, tapped and knurled as necessary.

However it is possible to obtain standard brass plumbing fittings, in Sydney at any rate, which make most of the metal turning unnecessary. What is required, following this route, is a reduction sleeve, threaded internally at one end, and a stop end which is then soldered into the smooth sided open end of the sleeve. A short length of threaded tubing is then required to screw into the reduction sleeve and this constitutes the main body of the arrester.

The hexagonal part of the reduction sleeve must then be turned off, to achieve the flange at the base and this is just possible in the electric drill. An ordinary nut can also be purchased to fix the body of the arrester into position.

The centre of the arrester consists of a piece of turned 'Tallow-wood' with a centre pin threaded at one end to provide the high voltage terminal. The main adjusting knob and its locking piece are again turned up and knurled as for the terminals described earlier.

Next we can turn to a piece of wood turning, as light relief after the first attempts at the metal turning in the lathe. In passing, the metal lathe can be used for cutting wood, even though it makes



The author's scaled drawings for the Tuner. Note that the section views are to a larger scale.

rather a mess and you risk mixing metal filings with the wood dust. If you do not have access to a wood lathe it certainly works however.

What is now required are a number of control knobs. After trying several different substances, ranging from compressed rubber to soft wood, the most satisfactory substitute for the genuine Ebonite was found to be Australian hardwood. This came from an offcut of garden fencing post. It is thought to have been Stringybark, being a pale reddish colour, after cutting and turning and before staining with Indian Ink.

In order to provide a mechanically sound centre, short brass rods were set into the underside of the knobs and drilled to take the shafts of the variable capacitors. These rods were fixed into position with the assistance of 'Araldite' 24-hour adhesive.

The one tricky job in replicating the knobs was to make the fine edge knurling which, because of the size, could not to be tackled with a normal metal knurling tool. In the end a special tool was made up from a piece of 25mm-diameter mild steel rod, consisting of a series of sharp edged grooves cut with a constant pitch of 0.5mm. This grooved rod was then turned at high speed in the lathe, and the edge of each knob set against it and turned slowly around by hand so as to form the knurling, letting the pitch of the tool set the groove spacing. Rather tricky, but the result was quite respectable. Not as fine and clean as the original but this can only be seen from quite close inspection.

For the tuning capacitors, which sit on the top of the Tuner, the knobs that have just been made are each connected to a circular flange of laminate, taken from the remaining part of the board used to make the front and sides of the case.

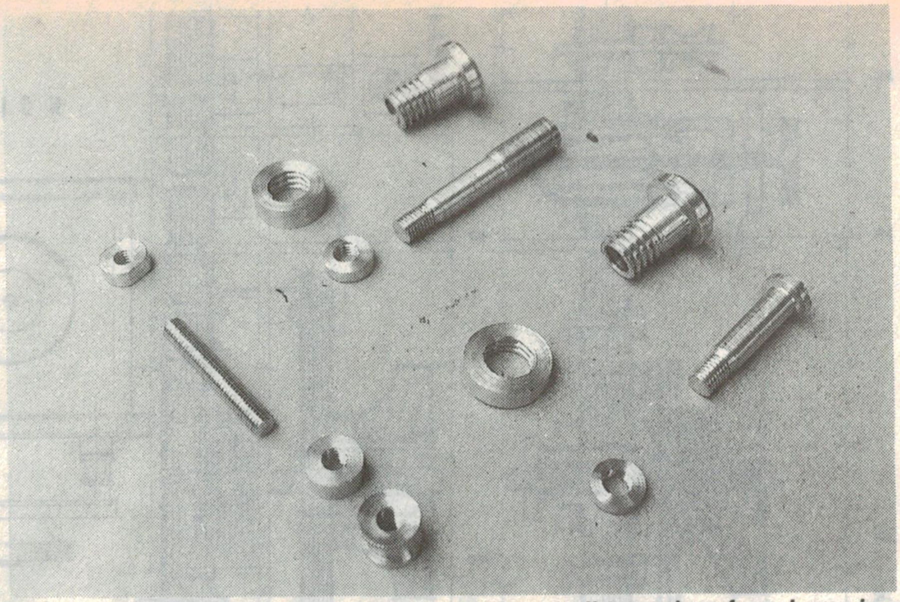
As noted earlier, this material is exceptionally hard and to cut out three exactly similar disks, a circle cutting tool, with an adjustable boom, was used. This was fitted into the electric drill while held in a drill press for accuracy. Later these disks were held in the jaws of a three-jawed lathe chuck and turned down to the dimensions indicated. At this stage the disks were also grooved to take the top of the brass cylindrical shells mounted on the top of the box.

A threaded rod was then put through the centre of the disks, one at a time, and bolted into position. This allowed the disks to be spun so that their edges were accessible and allowed the cutting of the stepped groove to take the brass straps around the edge of the disks. This ring of brass to each disk was made up from off-cuts from the brass tubing used for the capacitor shells. Being inevitably a little too small in diameter, the rings were cut and small pieces were added and soldered into position with hard solder.

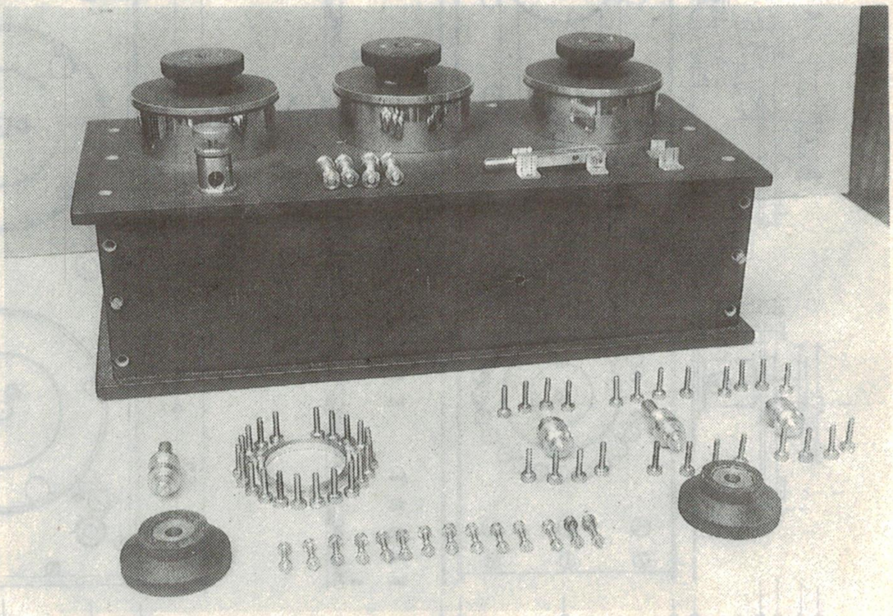
Small tuning capacitors were obtained from Mr L.E. Chapman, at North Narabeen, and these were fixed into position at the centre of each of the brass cylinders with small pieces of aluminium sheet bolted back to the ebonite case. In addition the knobs were fixed to the completed disks with nuts and bolts. Then, in turn, each completed knob and disk assembly was attached to the shaft of the capacitor with grub screws taken through the side of the knobs.

As can be seen, to each of the disks it is necessary to add a couple of flat topped studs, which were part of the original capacitor assembly, and also two round-headed bolts. None of these parts are strictly necessary for the operation of this modern replica, but are needed if one wishes to maintain the correct appearance.

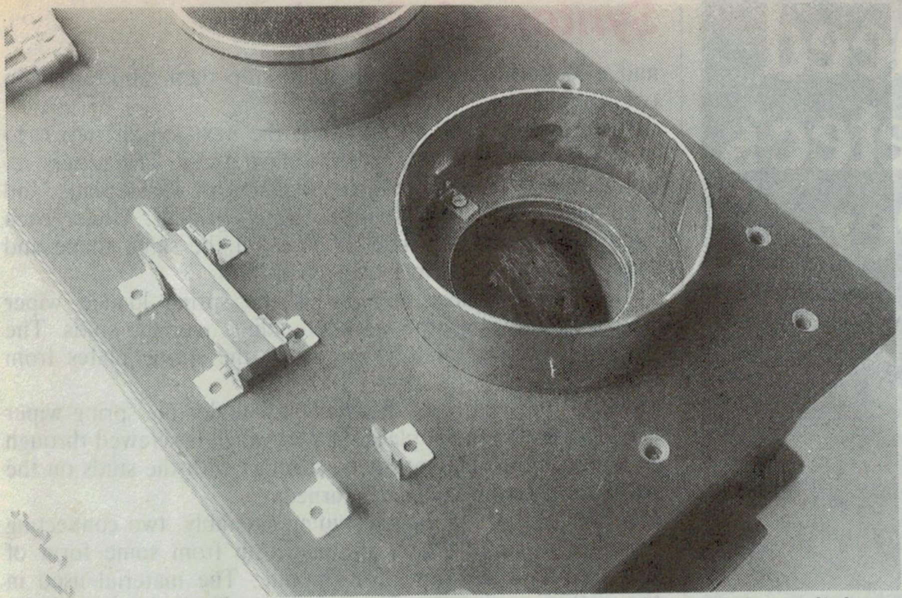
In order to complete the capacitor tuning assemblies, it is necessary to make up two pointer columns for each shell. In the original Tuner, these per-



A closeup of the terminals, spindle and collar – all turned up from brass in a small hobby lathe.



And here is just about all of the Tuner's brasswork, arrayed out in front of the main case.



A close-up of the top panel components, showing the changeover switch and the mounting for a tuning capacitor shell.

formed two functions. Firstly the top of each standard carried a pointer but, secondly, hidden behind each one was also a wiper which made the contact to the sections of the variable capacitor inside as the knob was turned. With the modern capacitors that have been used, the wipers are of course redundant – but their absence is not detectable except to the critical eye of the wireless fanatic: the author, perhaps!

Again the form of these standards is clear from the drawings and photographs. They are cut from angle brass and need to be extended somewhat to achieve the correct height to clear the surface of the disks. For this scraps of angle are silver soldered to the ends of the angle and then ground of on a bench grinder to a smooth surface before buffing up and fixing to the top surface of the tuner.

In order to fix these parts into position, it is necessary to use flat-headed bolts. Because nothing could be found of the correct dimension, they had to be fabricated out of 5/32″ round-headed bolts soldered to the underside of disks cut from a length of rod. As some 18 of these fixing bolts will be needed, now is probably the right time to grit your teeth and do them all as a batch!

The benefits of Henry Ford's production line suddenly start to make sense when such a task has to be undertaken, for by doing the same job 18 times it is possible to avoid continually resetting the lathe; and much time is saved. Again the drawings show the correct profile for these studs and it will be seen that the top of the original bolts has to be shaved to a parallel sided shape in order to obtain a proper surface for the solder to stick to.

Next the changeover switch can be tackled, and again this involves brass angle and flat pieces – no lathe work, other than the small knob to the change lever itself. This is fairly straightforward, except for making the threaded hole for the knob. In order to avoid splitting the laminate, it is advisable to hold the section between the jaws of a vice while the tapping is being done.

When at last all these components are in position on the top surface of the box, it can be seen that a major step to the construction of the Multiple Tuner has been taken.

Our attention can now be turned to the front panel of the Tuner, with the ganged tuning switch and Aerial tuner assembly. Again reference to the drawings will make clear what is required and fairly easy lathe work is needed to make up the shafts and collars for the knobs and wiper bars.

As before the tedious task is making up the studs on which the wipers will bear, since this involves the same problem of unavailability of a modern flat-topped bolt that can be used. You will probably guess that Henry's production line has to be invoked, to help you through the process of making up no less than 45 of these studs, which are somewhat smaller than those previously made. The only consolation is that these studs do not need the saw cut for a screwdriver.

On the principle of worst jobs first, we can now turn to the far easier task of making up the four sets of spindles and bearings. These items are all of generally similar construction, the difference being that those for the wiper bars are cut off shorter. In order to see what is required, reference to the large size detail drawings will reveal the important relationships. The outer retaining collars are drilled, once in position,

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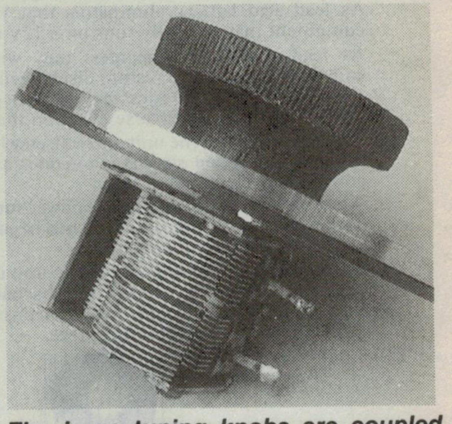

The large tuning knobs are coupled to small tuning capacitors, obtained from L.E. Chapman.

and a locking pin put through, to stop them unscrewing in operation.

Having completed the spindles, the next logical step is to make up the wiper bars and coupling straps. The wipers require cutting from a suitable thickness of brass plate, and then filing and shaping on the bench grinder. Under each wiper goes a thinner sheet of brass of the same shape and separated from the wiper by a small flat.

This thinner sheet material is the spring loaded wiper which actually does the work of sliding over the studs. The thicker plates are simply to protect the spring plates from damage.

As can be seen from the drawings, under the spring wiper at each end, has been placed a stud which is screwed through to the back and this makes the contact with the studs on the front panel as the knobs are turned.

In the case of the ganged tuning assembly, two connecting bars are required which are made up from some form of laminate as a substitute for Ebonite. The material used in the author's case came out of the radio junkbox and appeared to be a World War 2 version of Formica. These bars are fixed back to the wipers with four of those studs which were made up earlier.

Turning now to the Intensifier knob, located on the end of the Tuner, it should be noted that this is the only knob which is not knurled. The other odd thing is that the pointer is made from a piece of brass strap rather than from an angle, so that the corner is slightly rounded, rather than an exact right angle.

Once all the parts for the front panel are fixed in position, externally at least, the Tuner looks complete. However it requires to be wired up and for this purpose reference to the schematic is necessary.

For the coils the author used two relics from an earlier era and again culled from the junk box. The first coil came out of a WW2 tuner and has an internal variometer winding on a spindle. The second coil is quite similar, although of far less inductance and also has an internal variometer. The two variometers are then linked together internally with a chain drive, and one of the shafts projects out to be rotated by the single knob which is described as the Intensifier control. With this knob it is thus possible to control the degree of coupling, as the Variometer coils are rotated within their respective tuning coils.

For simplicity, the 'Tune' setting of the replica Tuner has been arranged to cover the Broadcast band only, whereas the original covered a far greater range. As can be gleaned from the references, in reality the Tuner was very rarely used in other than the 'Stand Bi' mode. This was because of the dramatic reduction in sensitivity which occured in the 'Tune' position, so limiting the latter's range of usefulness.

With the wiring in position, the job is complete and you can sit back and admire a fine piece of late Victorian engineering. The word 'engineering' is used advisedly, for clearly this device is much more an 'engine for tuning' than an electrical device. As can be seen from the illustrations, it exhibits the Victorians' particular skill for putting together fine looking machines, in which their appearance is a direct outcome of their purpose.

In conclusion, I would like to thank the Marconi Company at Chelmsford, England who gave access to archival records and apparatus and also supplied photographs, and also the Victorian State Museum, Melbourne, who provided photographs and dimensions.

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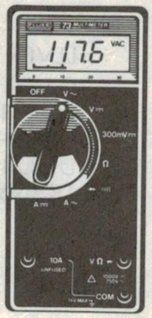

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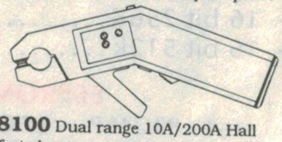

Y8100 Dual range 10A/200A Hall Effect clamp-on current probe

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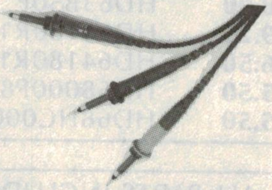

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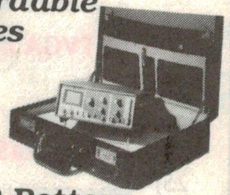

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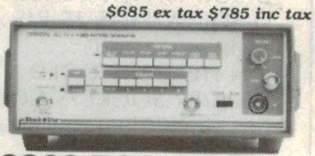

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ELECTRONICS • TECHNOLOGY
INNOVATION

LOUIS CHALLIS REVIEWS PHILIPS' NEW CD840 'BITSTREAM' CD PLAYER

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BUILD YOUR OWN BEAM FOR 50MHZ!

PHILIPS' NEW CD840 'BITSTREAM' CD PLAYER

Louis Challis has just checked out the latest Philips CD840 CD player, which carries oversampling to the ultimate degree: 256 times. Is the performance equally impressive? Read on, and discover what he found…

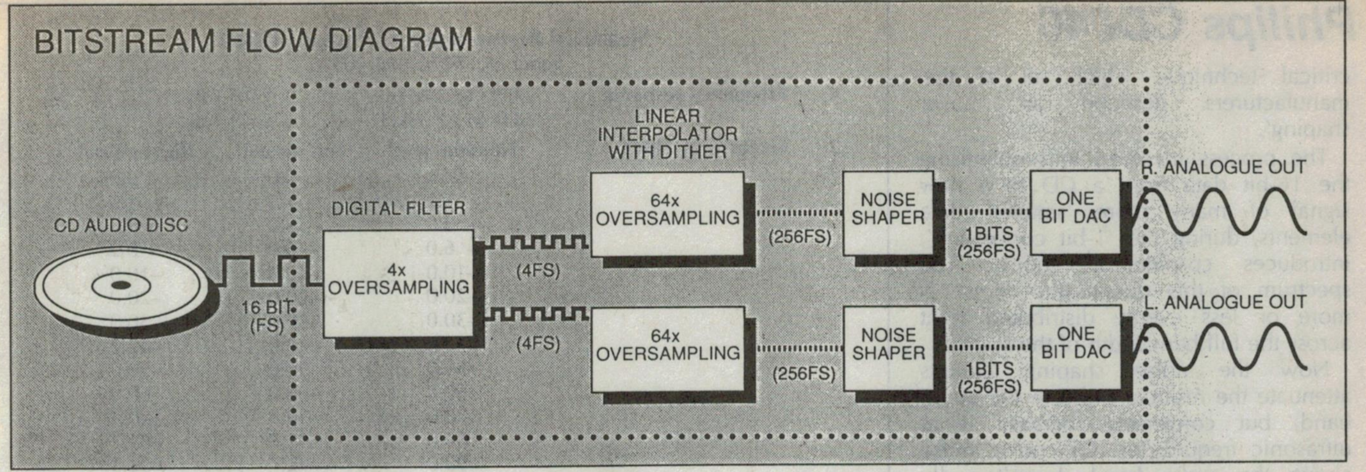
Just when I thought I had started to understand most, if not all, of the intricacies of 16 bit, 18 bit, 2-times, 4-times and even 8-times oversampling CD players, some boffin in the Einhoven laboratories of Philips got word of it and decided that he would change the ground rules once more. Of course, he wasn't the only one, for as I soon discovered Sony, Matsushita (National Panasonics to you) and JVC have all released 'One Bit' or 'Bitstream' CD players, to brighten your lives and mine.

Now most of you have probably grasped the basics of digital technology to the point that you understand the fundamentals of how a CD operates. But a 'one bit' player is likely to cause a technical regression in the minds of many, and I must admit in my mind too – although for a different reason.

However, before I progress further with this review, I had better go back to basics so that we have a common denominator from which we may progress.

Until now, all CD players used PCM (pulse-code-modulation) converters in which 14, 16, 18 or more bits are simultaneously converted into an analog voltage. A rapid succession of digital-to-analog (D/A) conversions at a rate of 44.1kHz – or, in oversampling players, some even multiple of that rate – is used to produce the output waveform.

But no matter how many bits are converted, or at what rate, the techniques are all quite similar. The waveform is constructed sample by sample, with each sample representing the amplitude of the waveform at that moment. One way of understanding the process is to think of the waveform as being similar to a staircase of building



Philips provides this block/flow diagram of the processing inside the CD840 player. Few details are available regarding what actually goes on inside the linear interpolation and noise shaping blocks, but note the reference to 'dither'.

blocks. The height of each step is equal to the number of blocks used to build it.

Although this analogy is fine, the height of a step may not correspond to what you would expect from multiplying the height of an ideal block by the number of blocks used to create the step. The most significant problems occur with the lowest steps. When there are relatively few blocks, an error in the size of any one of them can result in a relatively large proportional error in the 'step height'.

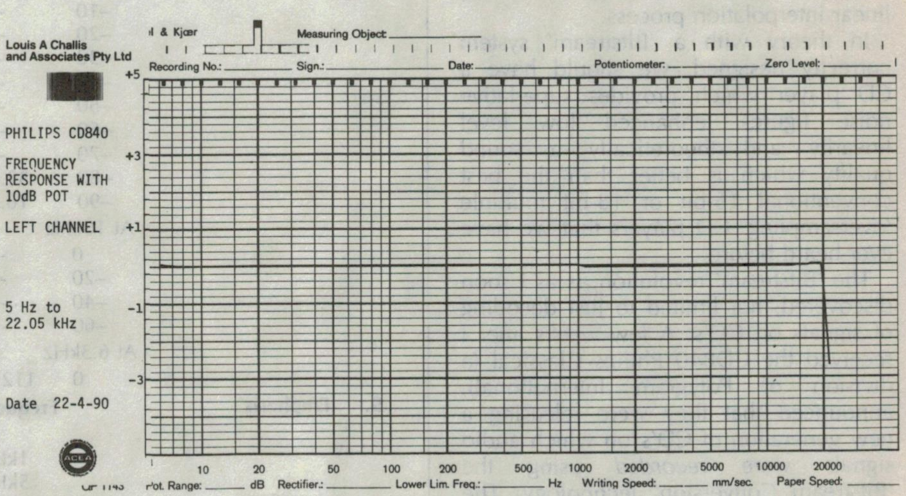
By analogy of course, this same problem is true for audio conversion in your CD player. Low-level non-linearity is the one aspect of digital audio systems the manufacturers tend to conveninently ignore when describing the characteristics of their systems. If you have studied the test results of my previous reviews, you will have observed that all CD players have significant non-linearities in the –70dB to –90dB range.

To overcome this problem, the 1-bit converters or 'bitstream' CD players take an entirely new approach to the problem. Instead of using 16 or more bits, they use 1-bit signals produced at a very fast rate – in the order of 11MHz, which is of course, 256 times faster than the data output from the CD disc itself. You might then ask, "How can a single bit construct an audio signal As we all know, a bit can only represent two values, either a 'zero' or a 'one'!

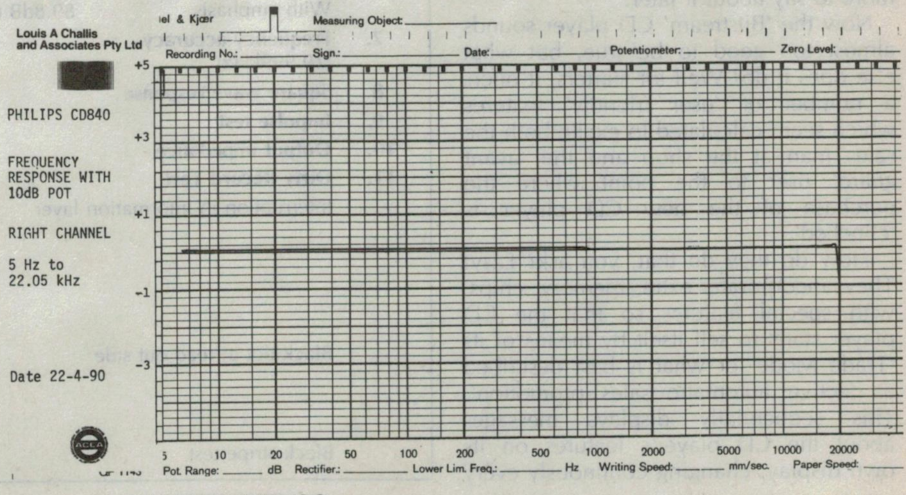
Obviously with that sort of operation, it can only be the varying ratio of positive to negative pulses that determines the shape of the final analog waveform. Such a system might well create a net value of zero. If however, the positive pulses predominated, then the waveform would have a positive amplitude.

Now in most practical systems, the output from the D/A converter can be configured in a number of different possible formats such as a pulse-density modulation (PDM) system, or more commonly as a pulse-width modulation (PWM) system. Irrespective of the format chosen every pulse is either of exactly the same duration (in PDM) or of a duration that is an exact multiple of a pulse one unit wide (PWM). Linearity is thus theoretically perfect at all possible operating levels. In practice, as we shall see, that level of perfection is not achieved.

As it transpires, a further element is required in the system to make '1-bit conversion' practical. This is an equally



With a response flat to within 0.1dB from 5Hz to 22.5kHz, the CD840 produces what must be about the flattest frequency plots yet.



Philips CD840

critical technique which all of the manufacturers describe as 'noise shaping'.

The process involved in requantising the 16-bit data from a CD to a new signal of many more 'smaller' data elements, during the '1-bit conversion', introduces considerable noise. The spectrum of this quantisation noise is more or less evenly distributed right across the full bandwidth of the system.

Now the noise shaping circuits attenuate the residual noise in the audio band, but conversely increase it at ultrasonic frequencies. Of course noise above the audio band doesn't really concern us as we are able to conveniently filter it out. This approach results in a marked decrease in noise below 20,000Hz, where we don't want it. So with a 1-bit D/A conversion and an optimised noise shaping circuit we should get very low noise.

The simplified circuit block diagram of the CD840 is shown in Fig.1, and one of the important features that it reveals is the introduction of a 'dither' into the linear interpolation process.

In theory with a 'Bitstream' system correctly designed, we should have a CD player which provides superlative noise figures, enhanced low level linearity and theoretically a sound quality which is better than the best conventional 16-bit or 18-bit multiple 'oversampling' CD players that we have ever heard before.

The 'Bitstream' revolution, is as I soon discovered, not limited to just decoding of signals on CD's. A few weeks after I received the CD840 Philips Classical (a division of Polygram International), announced that they were releasing a new generation of CD's on which audio signals were *recorded* using the 'Bitstream Conversion' technology. The first of these discs was lent to me to gauge my response, and I will have more to say about it later.

Now the 'Bitstream' CD player sounds almost too good to be true, but what else does it do? Well for starters, it offers a number of 'user friendly' features which seem calculated to excite both the sales man at the shop and the 'avant guard' user to the point where the purchase of the new CD player is 'clinched'.

How do they do that, you ask? Easy! They incorporate extra memory chips, with special features so that the CD player starts to sell itself by means of its 'Trade Mode' or what is best described as 'active automatic sales promotion'. This sequentially displays messages about the CD player's features on its own display, changing continously every

Measured Performance of Philips CD840
Serial No. 9070 088 40055

1. Frequency response

20Hz to 20kHz	+/–0.1dB
5Hz to 22.05kHz	+/–0.1dB

2. Linearity at 1kHz

Nominal level	Left output	Right output
0dB	0.0	0.0
– 1.0	– 1.0	– 1.0
– 3.0	– 3.0	– 3.0
– 6.0	– 6.0	– 6.0
–10.0	–10.0	–10.0
–20.0	–20.0	–20.0
–30.0	–30.0	–30.0
–40.0	–40.0	–40.0
–50.0	–50.0	–50.0
–60.0	–60.0	–60.0
–70.0	–70.4	–70.4
–80.0	–81.7	–81.7
–90.0	–92.7	–93.3

3. Channel Separation

Frequency	Right into left (dB)	Left into right (dB)
100Hz	–96	–95
1kHz	–97	–95
10kHz	–95	–94
20kHz	–94	–93

4. Distortion

Level	2nd	3rd	4th	5th	THD%
At 1kHz					
0	-	103.3	-	-	0.0013
– 1.0	-	109.8	-	-	0.0006
– 3.0	-	110.5	-	-	0.0005
– 6.0	-	108.5	-	108.1	0.0009
–10	-	101.6		103.1	0.0019
–20	-	92.4	-	95.1	0.0052
–30	-	80.3	-	84.6	0.020
–40	-	71.0	-	70.9	0.067
–50	-	60.8	-	67.8	0.18
–60	-	45.9	-	55.8	0.53
–70	-	42.4	44.7	36.5	1.78
–80	32.2	36.5	33.3	26.5	5.94
–90	16.7	30.4	16.9	13.3	29.9
At 100Hz					
0	-	102.7	-	110.9	0.0014
–20	-	92.2	-	92.1	0.0058
–40	-	75.3	-	74.0	0.043
–60	-	45.8	-	52.6	0.56
At 6.3kHz					
0	112.1	98.1	-	-	0.0025

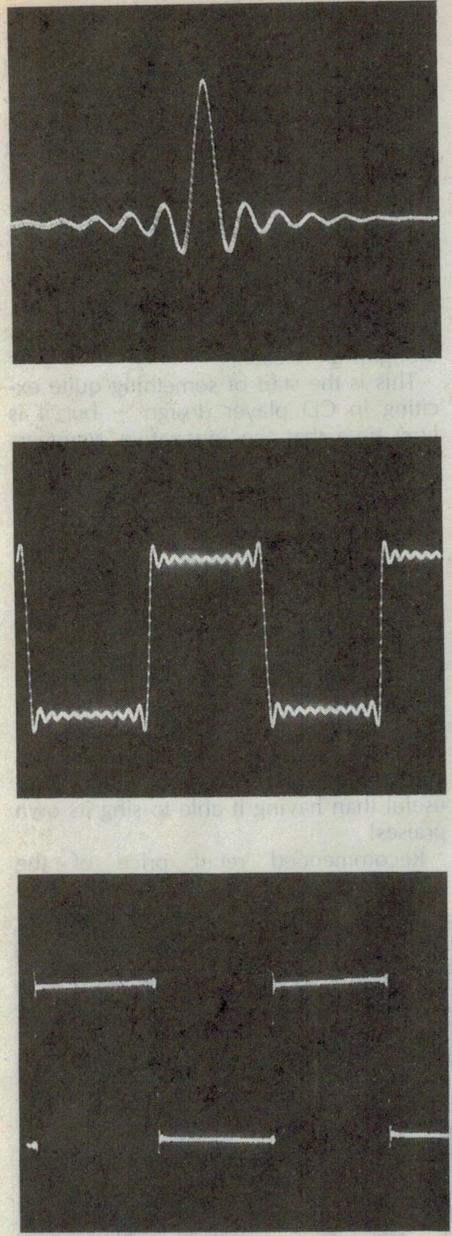
5. Emphasis

Frequency	Recorded Level	Output Level (L)	Output Level (R)
1kHz	–0.37dB	–0.4	–0.4
5kHz	–4.53dB	–4.3	–4.3
16kHz	–9.04dB	–8.7	–8.7

6. Signal to noise ratio

Without emphasis	73.8dB (Lin)	91.0dB (A)
With emphasis	89.8dB (Lin)	105.0dB (A)

7.	**Frequency accuracy** (19.999kHz)	+/–0.3Hz for 20kHz test signal
8.	**Square wave response**	(See attached photos)
9.	**Impulse test**	(See attached photos)
10.	**Output impedance**	Head phone output 150 ohms
11.	**Dirty Record Test**	Using Philips NR4A (410-056-2)
	Interruption in information layer	400 micrometer; Passed
		500 micrometer; Passed
		600 micrometer; Passed
		700 micrometer; Passed
		800 micrometer; Passed
		900 micrometer; Passed
	Black dot at read out side	300 micrometer; Passed
		500 micrometer; Passed
		600 micrometer; Passed
		800 micrometer; Passed
	Black stripe test	Passed



As you can see from these scope shots, the impulse and square-wave performance of the CD840 are also quite impressive.

3 seconds. It's certainly new, but it's also a sure sign that we have now reached the 'hard sell era', which in my language says 'buyer beware'!

Fortunately, the CD840 has other 'more useful' features, including the FTS or 'Favourite Track Selection' feature which is currently a Philips exclusive.

The FTS concept works on the basis that you can have, say, up to 254 CD's. For each of these you can store information on the tracks you want to play, brief text information on the title, or on the musician(s) or other brief descriptive data on the tracks. The FTS system even remembers how many times you've played that track. More intriguingly, this facility has been duplicated so that your wife (or husband, girlfriend, boyfriend, brother or sister) can be provided with an additional (one only) separate FTS memory. The blurb suggests that this feature will avoid family feuds – but I wonder!

Because the FTS system could easily get out of hand, the CD840 incorporates another feature called FTS-INFO, which summarises the state of the FTS1 and FTS2 memories, with five modes which show the number of discs programmed in FTS1, and similarly for FTS2, as well as the memory space still available. This shows in sequence the number of each disc, the number of times it has been played and where recorded, the title, or other information limited to 12 letters.

So in effect, you have a special data recorder, which you can use to store your information. Although the more pendantic 'upwardly mobile' user will revel in it, I fear that more than a few users will tend to be discouraged. Alas what these 'third generation' CD players should really be doing, I believe, is reading the title description straight from the subcarrier information stored on the disc itself, with only minimal supplementary help from the owner in terms of his or her preferred tracks.

The next feature is the player's provision of a series of personal preset options which allow the user to provide automatic start, auto stop, auto play, or auto random play of a complete disc or of a nominated FTS1 or FTS2 program.

Another feature provided, which I really didn't expect, was the incorporation of the 'CD RECORD SYNC' facility. When this CD player is interconnected to a Philips cassette deck which incorporates the Philips 'CD record synchronisation' circuitry (with the special RC-5 interconnection cabling), perfect record synchronisation is ensured with the recorder sequencing, reversing and overall control provided automatically by the CD840's internal circuitry.

The remote control key pad provides edit information so that the cassette length can be entered in minutes (C60, C90, C100). The CD player will assess the encoded time information on the disc, to determine whether sufficient tape length is available for recording all or as necessary, a limited number of the tracks on that disc.

Other worthwhile features provided include an optical digital output and a coaxial electrical digital output, as well as the normal left and right channel analog outputs on the back panel. These are supplemented by a headphone socket with its own separate volume control on the front panel.

The CD840 also provides an A/B segmental automatic cycling replay facility, as well as a 'display dimming' function. Most of the special controls are incorporated in a linear array of pushbuttons along the median line of the front panel. The player is incorporated in a solidly made cabinet which is described as a 'Computer Designed Box Frame'. The construction concept uses a box shaped cabinet which achieves a far higher stiffness and interpanel rigidity than is normally achievable with a conventional chassis structure.

On the bench

When we started to test the CD840, I had high hopes that it would out-perform all the other CD players that I had previously reviewed. And in some areas this proved to be reasonably close to the mark.

The first parameter we tested was frequency response, which is just about the best we have seen – being within +/– 0.1dB from 5Hz to 22.05kHz. So far so good.

Next we tried the linearity. Instead of the perfection that I had hoped to find at –80dB and –90dB, the deviations were measurable at –1.7dB and –2.7 to –3.3dB respectively – fair to good, but not really outstanding.

The channel separation exhibited characteristics which were essentially flat with increasing frequency, and better

Philips CD840 Bitstream CD Player

than 93dB at all frequencies. This I feel, is most commendable and generally so close to perfect that these numerical values don't warrant any further improvement.

The distortion characteristics were good all the way down to –70dB, beyond which the laws of nature stil prevailed – as the number of significant bits limits what can be achieved. Alas, at –90dB the 29.9% THD is no better in this CD player than it's been in any other that I have yet tested.

Similarly, the signal to noise characterstics of the player are good, but not nearly as good as I have now come to expect from the best 18-bit players marketed by any of Philips competitors.

In all other respects the objective test results of this player are very good, and apart from a slightly noisy cassette drawer motive system, I couldn't really fault any of the objective test results.

Listening tests

The subjective evaluation of the CD840 proved to be generally a delight, as I had some exciting new software with which to assess it. I admit that I enjoyed the opportunity.

The first disc I played was Schoenberg's 'Pelleas and Melisande', with Daniel Barenboim conducting the Orchestra de Paris (CBS Masterworks MK 38557). This mysterious and dream-like 'ton poem' in four movements is a moving piece by one of the most influential figures of the 20th century music. Schoenberg as I discovered, had no formal training in theory or composition, yet his music provides no clues to his limited training. The CD840 delivered a brilliant rendition of the music with truly outstanding colour, clarity and realism.

The next pair of discs I played were Donzetti's Opera 'L'Elisir d'Amore' with John Pritchard directing the Orchestra and Chorus of the Royal Opera House of Covent Garden (CBS M2K 79210). Although the recording of this opera is ADD, it is a superb example of the best characteristics of analog primary recording, and its qualities of realism were magnificently displayed by the players. This is one of the best opera disc recordings I have recently heard and the CD840 extracted the full capabilities of the discs.

The last disc that I played was Stravinsky's Ballet 'Pulcinella' with the City of London Sinfonia, conducted by Richard Hickox (Virgin Classics VC 790767-2). This bright and exquisite ballet is one of Stravinsky's most critically acclaimed works, as it was the first of what has since been described as his 'neo-classical' conducting period. Few realise that this piece was based on music originally composed by the Italian Giovanni Pergolesi 200 years before. The music was haunting and the quality of reproduction positively exciting.

After three days of playing the CD840, I was reluctant to give it back. But my thoughts are clear.

This is the start of something quite exciting in CD player design – but it is now time that the innovative engineers at Philips took the FTS concept through a further quantum leap and programmed the player to read the appropriate subcarrier information which will then tell us the title of the track, the musicians and other equally pertinent information so that we don't have to do all the hard work ourselves.

More pointedly, if the 'Bitstream' CD players are to deserve the title 'State of the Art', then they must be provided with a remote control able to control volume level. That would be rather more useful than having it able to sing its own praises!

Recommended retail price of the CD840 is $879. •

Loaded with electronics:

The new Arriflex 535 motion picture camera

Despite the advances of high definition video systems, the technology of choice for large-screen visual presentation is still motion picture film. Paradoxically, the latest professional camera from West German makers Arnold & Richter shows the extent to which film technology has been able to take advantage of recent developments in electronics.

by BARRIE SMITH

In terms of technology, the Japanese have proved they can match the West in most areas – not only in development, but in its application to new products, and getting these revolutionary products to market.

One of the few areas not yet occupied by our high-tech Asian friends is the professional motion picture camera – using 16mm, 35mm, or 65mm film.

Currently, four main manufacturers are engaged in producing motion picture cameras for world markets: Panavision Corporation, of the USA; IMAX Corporation of Canada; Moviecam, Austria; and Arnold & Richter, West Germany.

Of the four, Panavision and IMAX are the exceptions in that their equipment is not sold, but rented by the day, week or month. And Panavision's inventory includes not only motion picture cameras, but almost the entire support system to shoot everything from TV commercials to full-blown feature films: from steady mounts to tripods, from lenses to director's viewfinders.

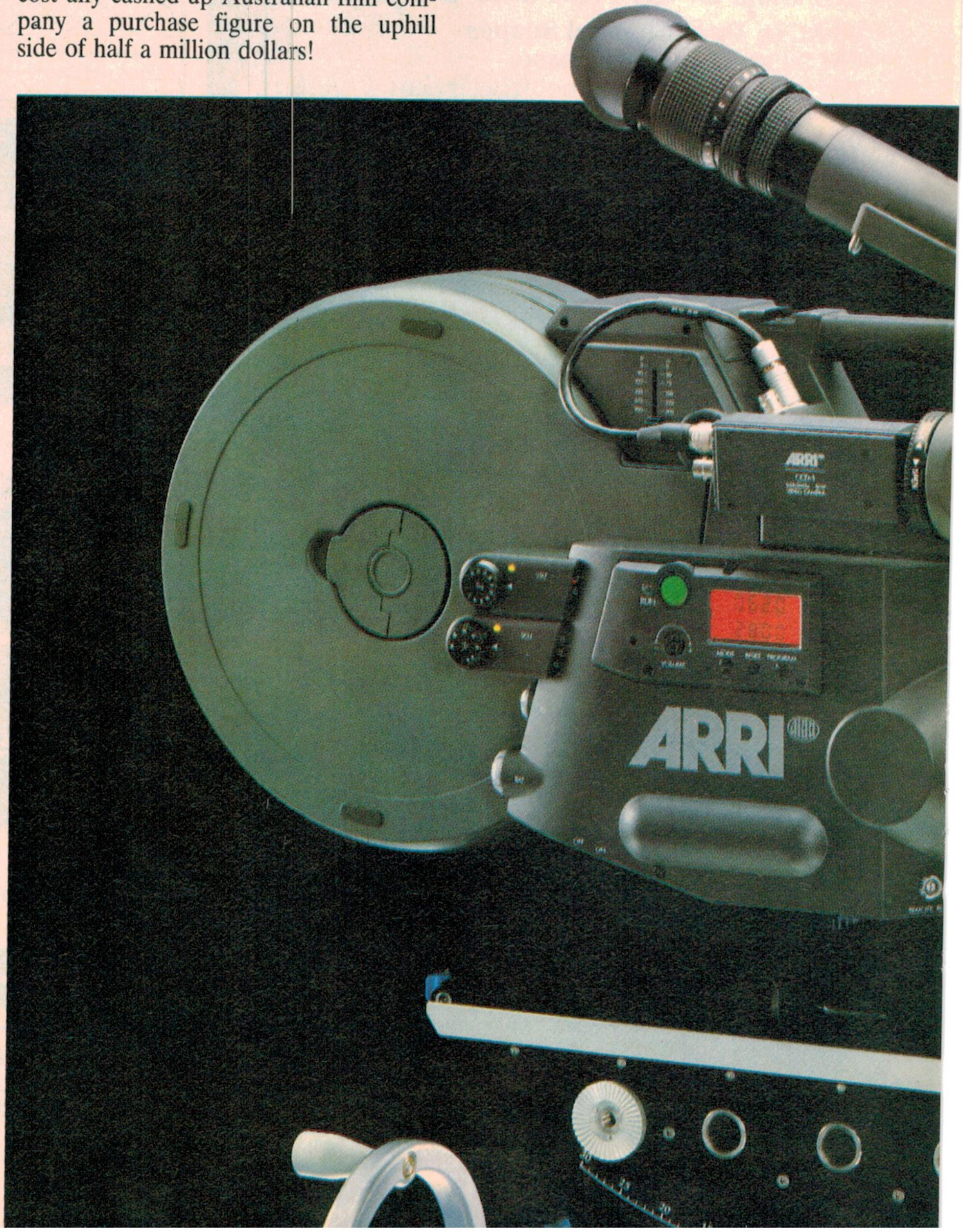
IMAX for their part, are solely engaged in producing the specialised cameras and projectors (plus theatres) for their horizontally-running 70mm mega screen systems, IMAX and OMNIMAX.

Panavision delivered their last major model change in 1987 – the Panavision 'Platinum' 35mm camera; Moviecam's Super 35mm appeared in 1984; and now Arnold and Richter have produced their latest production model – the Arriflex 535.

With only four main companies in the field, it may come as a surprise to learn all are fiercely competitive. Design advances appear on the horizon with great rapidity, after long periods of development gestation under heavy security.

The need for fierce competition may also be a matter of question when it's learned that the Arri 535 will probably cost any cashed-up Australian film company a purchase figure on the uphill side of half a million dollars!

Arri have been making cameras since the 1930s – their combat cameras saw action in the hands of WW2 German newsreel cameramen. Some of their im-



mediate post-war models, particularly the IIb, are still in use by companies both here and overseas. In the right hands they can turn in shooting almost indistinguishable from high-tech, high-cost 1980s models.

But time is running out for these veterans, and for those cameramen who think they can 'get away' with a 30-year-old camera.

HDTV is on the way, with its voracious demand for high resolution images attractively married to high fidelity, low noise audio.

Despite its beginnings as a maker of simple, rugged combat cameras, the Arri company have produced a camera they feel will answer HDTV's demand for high quality images. And the new camera's design philosophy and operational features delve deeply into electronics technology, interfacing to the world of video as never before.

The new Arriflex has attacked the two main bugbears of high level production with film cameras – film steadiness and camera noise, by some novel engineering and acoustic design.

Video & Film Time Codes

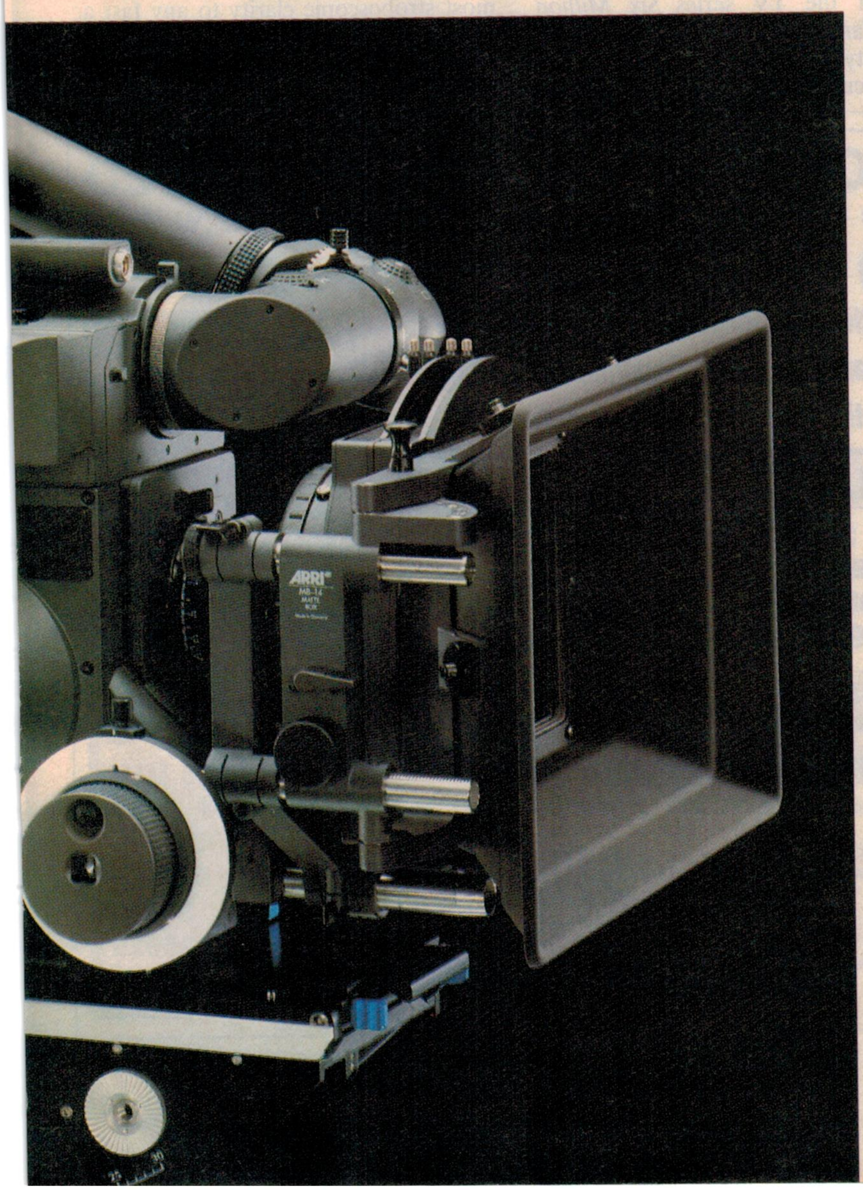
SMPTE/EBU Time Code provides machine-readable addresses for each picture frame, and has a length of 80 bits per frame (2000 every second in PAL). Each frame is identified as to the hour, minute, second, frame (32 bits), plus up to 8 x 4 digit characters of user information (32 bits) – and a special sync word indicating the end of each frame and direction of tape travel (16 bits). The code is recorded longitudinally in the audible range.

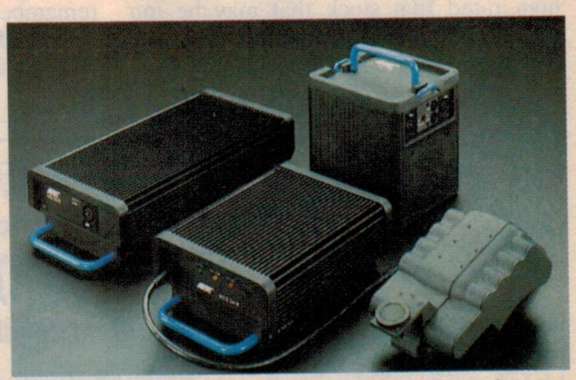
Currently, there are six video time codes worldwide, plus a number developed by motion picture camera manufacturers, and an up-coming system from Kodak – Keykode.

In other functions new design approaches have been adopted – microprocessor circuitry monitors film travel, shutter timing and drive torque; an outboard CCU (camera control unit) allows the operator to pre-set functions such as filming speed, shutter angle, and various modes such as time code imprints and viewfinder displays; provision is made for video split viewing on-set, and a form of SMPTE time code is imprinted on the film's edge, without disturbing compatibility with Kodak's new Keykode system.

Film steadiness: The film transport uses a 7-link, quietened movement and sprocket wheels; dual register pins accurately position each frame of film for exposure, assuring a high level of picture steadiness. No rotating cams or followers have been used, so the dynamic efficiency, low mass and low wear should result in a precise, reliable and service-free film movement.

Operating noise: A rigid mechanical connection between lens mount and the film's focal plane has been standard Arriflex practice. However, a rigid connection throughout the camera can contribute noise from the vibration of moving parts. To overcome this noise the lens mount/focal plane unity is maintained, whilst insulating the inner skeleton of the film drive from the outer body of the camera. The current noise level is





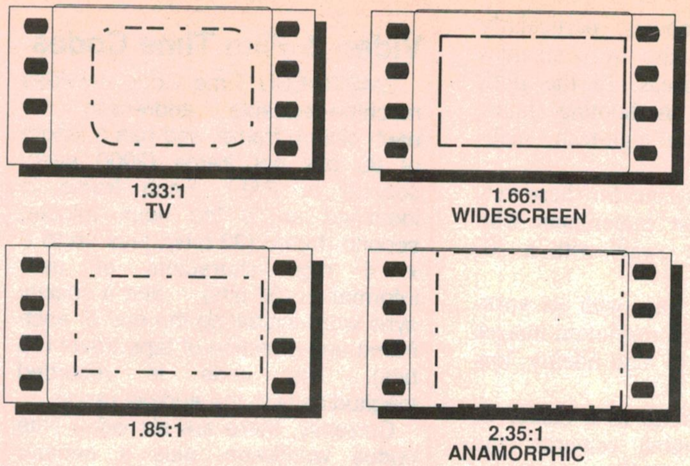
The 535's power supply accessories: heavy duty and on-board battery packs, AC unit and charger.

The 535's two-tiered camera control unit, which allows programming of a wide range of functions.

Arriflex 535

claimed to be better than 20dbA, and is expected to improve as the cameras are bedded down in actual production use.

The camera drive uses a 24 volt quartz-controlled disc-type DC motor, drawing 2 amps at 25 frames per second. Crystal control guarantees frame rates of 3-50fps forward, and 24/25fps reverse, plus presets for 24, 25, 29.7 and 30fps. Speeds can be preset, and are programmable into, and stored in the camera's running program. Programmed speed changes can be automatically activated at any time.



Four of the eight standard filming aperture formats which can be displayed in the 535's viewfinder.

Variable Shutter: The 535 has a programmable, variable shutter. Using microprocessor circuitry, both variable shutter opening and frame rate may be preselected and activated without add-on accessories. The mirror shutter opening may be adjusted continuously from 11° to 180°, at any camera speed.

Variable angle shutters have an important place in film production. They can reduce the exposure without changing the lens aperture; cope with very high rated film stock that may be too fast for the lens's minimum aperture; allow the correct shutter angle for filming in HMI enclosed discharge lamp illumination (in 50Hz environments 25fps and a precise 172.8° shutter angle is obligatory); allow synchronous filming of a TV set without frame roll (PAL TV requires 25fps with a 180° shutter angle).

The 535's microprocessor-based program also permits 'in-shot' changes of speed and shutter angle, with precise exposure compensation.

This feature is of interest to makers of TV commercials, and film directors working in the sci-fi genre: if you remember the TV series *Six Million Dollar Man*, and Lee Majors' remarkable ability to break into a gallop with nary a cut, dissolve or any visible change of exposure, a similar system was used. As the camera changed from normal 25fps to higher frame rates (slow motion), the auto exposure circuitry adjusted the lens aperture in compensation.

Arri's contribution, using shutter angle and frame rate produces the same, visually smooth result. But with one unusual side effect: the increase in framing rate, coupled with increasingly smaller shutter angles will impart an almost stroboscopic clarity to any fast action photographed in this manner.

The outboard CCU lets the operator preset a number of camera functions be-

fore shooting begins: pre-programming the camera's shutter angle and filming speed for later on-board control; presetting of the camera's mode selectors and time code functions; viewfinder display; a quick overview of the camera's operational status, and a self-diagnostic check of the camera's electrical circuits.

A plug-on 2/3" CCD sensor video camera for viewing assist is designed to become integral with the main body of the camera. Horizontal resolution is claimed to be over 750 pixels.

In the past, video assist on motion picture cameras has often given a poor rendering of what's coming in through the lens – due to the presence of flicker, burn in, lag, geometric distortion, poor flare characteristics, low resolution and luminance levels of conventional sensors. The advent of CCDs has changed all this, plus the use of a beam splitter with variable ratios (viewfinder: video – 50:50, 80:20 and 0:100). These hand the Director the inimical choice of who sees the better picture – the DOP (director of photography) or himself.

Dual LCD Displays: Placed on both sides of the body, the LCD displays show feet/metres, frame speeds and shutter angle. The LCDs also display microprocessor message alert numbers when the 535's self-diagnostic program determines improper usage – as with incorrect threading or door left open, or possible software malfunction. The LCDs enable the user to know more about the internal and external status of a camera than ever possible before.

An LCD display in the viewfinder shows the cameraman the appropriate framing for the aspect ratio the film will be shown in – 1.33:1 for TV, 1.66:1 for wide screen, 1.85:1, 2.35:1 and so on. There are up to eight choices, with the ability to display any three at any one time.

SMPTE Time Code: The 535's integral Time Code generator provides full SMPTE RP 135 and RP 136 80-bit time code capability, and is designed to accommodate all foreseeable applications for SMPTE time code in the future. The code information is recorded between the edge of the picture frame and the perforations. In anticipating the information needs of the industry, the 535's time code system is also compatible with Eastman Kodak's new Keykode edge numbering system. On board time code can be set for 24, 25, 29.87 and 30fps filming.

The new Arri 535 is a radical departure for motion picture camera design, and the Munich company is confident it is "a camera with which we are absolutely convinced that we can pursue technological leadership in this market".

It's been six years since the company's last model launch.

Obviously, the market for a new, albeit expensive, 35mm motion picture camera is an attractive one. Arri have spent two and a half years developing the 535 – and now, yet another model the 765, a 65mm production camera has been announced.

But it's up to the world's cinematographers to decide whether the time is ripe for a new, decidedly complex 35mm motion picture camera. They'll have the chore (and pleasure) of using it, although generally not the burden of paying for it. •

The 'film look' and HDTV...

It is the opinion of the writer that no matter what developments are made in electronic imaging techniques, it's doubtful that video, as an image source, will ever be able to provide the level of resolution, definition and colour fidelity demanded by the higher quality of the HDTV system.

To explain: the 1125 line HDTV system operates at 30 frames per second; in this format each frame carries 532,836 pixels of image information.

By comparison, each frame of 35mm in the TV screen aspect ratio of 1.33:1 has 7,069,230 pixels – running at a speed of 24 frames per second. A high definition TV camera and recorder would need the equivalent – in digital or analog format – of 3248 scanning lines per frame to match the capacity of a single 35mm frame.

The 'film look' is constantly heard as a reference standard when judging programme material for TV broadcast. This 'film look' is the result of each film frame combining the elements of advanced physics and chemistry, with the random arrangement of actual dyes creating a picture the eye accepts as reality.

Film has a greater dynamic range and sensitivity, with a capacity to reproduce a broad spectrum of colours, and wide band of neutral tones. Most films have a greater exposure latitude than video materials, along with ability to handle excessively bright highlights, and reach into near-black shadows.

ETI PROJECT 783:

BUILD YOUR OWN BEAM FOR 50MHZ

Six metres has put on some spectacular DX recently. This easy to build beam – for home station or portable operating – will help you get amongst some of the action.

by ROGER HARRISON, VK2ZTB

With the solar cycle running at its peak, the 50MHz band is putting on some spectacular DX – and will continue to do so over the next couple of years, going by the performance of past solar cycles. To make the most of it, you need a six metre rig, some finely-honed operating, a little patience and a beam. This four-element Yagi design is modest in cost and can be built for 'permanent' siting, or as a 'collapsible' antenna for portable applications.

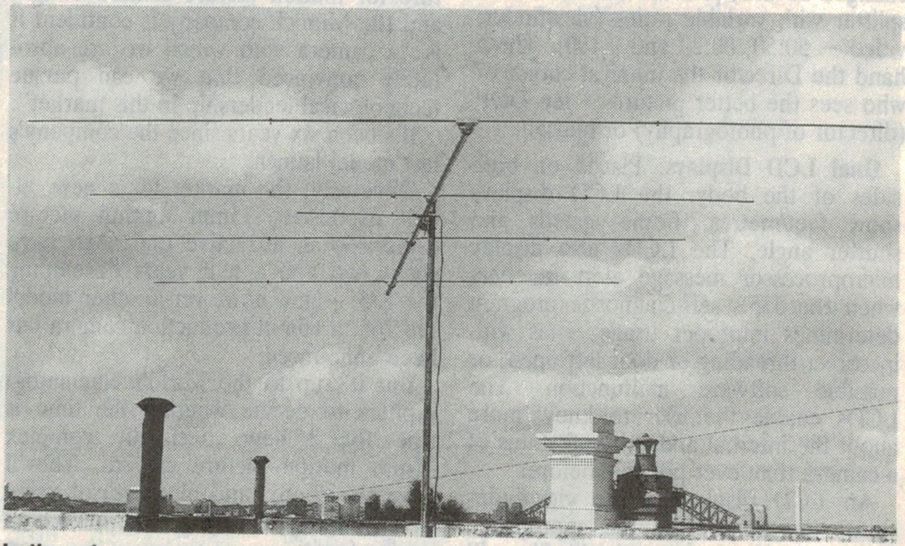
Since the use of 200kHz of the 'bottom end' of the six metre band was returned to Australian amateurs, just in time to catch the spectacular rise of Solar Cycle 22, there has been an upsurge of interest and activity in and on 50MHz around Australia. And the number of callsigns appearing on the band continues to grow.

Wishing to join in, too, I dusted off my erstwhile moth-balled six metre rig and tackled the next job: the antenna. What would I go for – Yagi, log-periodic, log-Yagi, cubical quad, or what?

Well, I had a quad for 28MHz, so adding elements for 50MHz was a proposition. However, I wanted more gain, the aim being to get more *effective radiated power*, or ERP. Multi-element quads get a bit unwieldy, so I scotched that idea.

Of all the designs one can consider, inevitably the choice comes down to the Yagi because it delivers 'the best bang for your buck', as the Americans say. That is, for the amount of hardware you erect, a Yagi gives the most gain. Mind you, there's not a lot in it with a three-element Yagi; the differences start to matter with four elements and more.

So the choice then became: four elements, five elements, six or more?



Let's get amongst some of that intercontinental DX! The beam is mechanically simple and easy to assemble, using common hardware items.

For practicality I opted for four elements, as an array of this size for six metres is easily handled by one person – and that was going to be me! I also had in mind the eventual aim of putting up stacked four element Yagis, since a great body of practical experience suggests this lowers the radiation angle. And much long-haul DX on six metres exhibits very low angles of arrival.

The design

Design dimensions for amateur band Yagis are no secret – the *ARRL Handbook* and *ARRL Antenna Book* provide a ready source. It's the individual mechanical details and perhaps the matching methods that really distinguish one design from another. And the ARRL publications are not short on mechanical construction ideas, either.

One of the objects of this design was to use hardware items which were readily available from local hardware suppliers. It is fortunate that there are now many specialist aluminium product suppliers around Australia, where tubing, sheet and various drawn sections (angle, square tube, etc) are obtainable. Some hardware chain stores stock a selection of tubing and angle, too.

The general dimensions of my four element Yagi are given in Fig.1. It is based on a successful design I used much earlier, which was known as 'four elements on a 12 foot boom'. Note that I have not used even spacing between elements. The first to second director spacing is 0.2 wavelengths, while the driven element to first director spacing is much smaller.

If you use a boom length of 4000mm

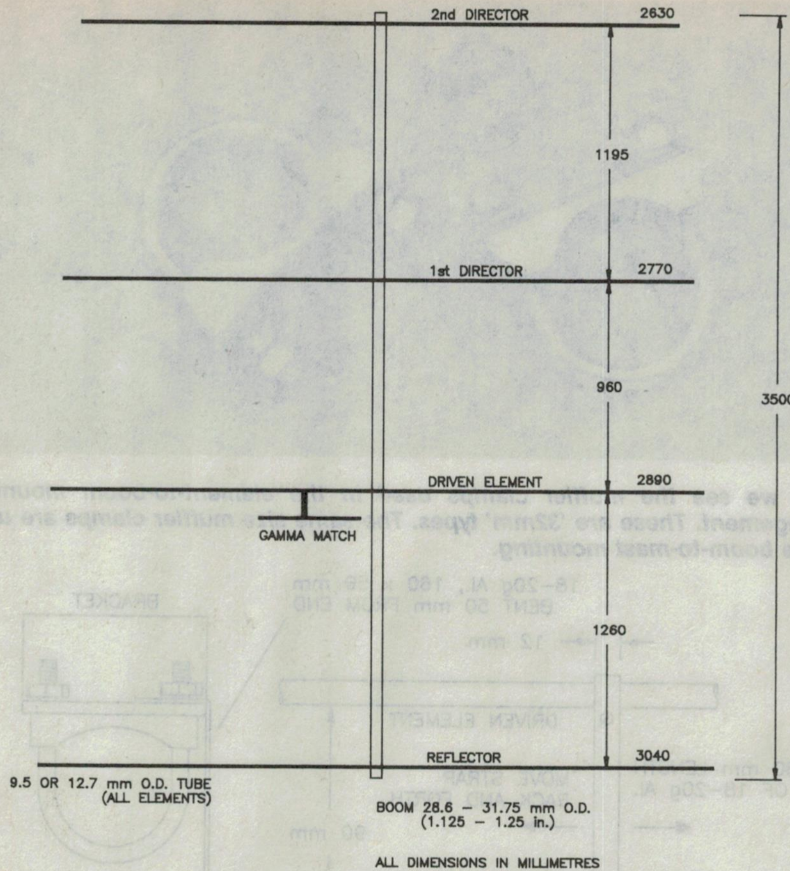


Fig.1: General design dimensions of the four element 50MHz Yagi, centred on 50.1MHz. Note that the inter-element spacings are centre-to-centre dimensions. However you can assume a 5mm tolerance on all dimensions. The elements can be cut from 12.7mm or 9.5mm o.d. aluminium tubing, but the ends of each element in the author's beam were 9.5mm tubing slipped inside 12.7mm tubing. The construction alternatives for the elements are discussed in the text.

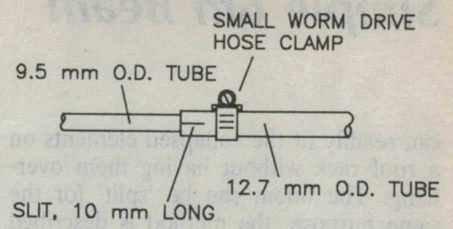


Fig.2: The centre half of each element is cut from 12.7mm o.d., 1.6mm wall aluminium tubing. The element length is then completed with a length of 9.5mm o.d. aluminium tubing slipped inside each end. Two 10mm long hacksaw cuts are made at right angles in the ends of the larger tubing so that the smaller tubing can be secured by means of a small worm-drive hose clamp. When the correct element length has been determined, the 9.5mm diameter tubing can be scored around the circumference right at the join, to mark the set position.

(4m), you can use 0.2 wavelength spacing between the driven element and first director too, optimising the gain. However, the spacings here and tapered element lengths provide more bandwidth, enabling me to listen for intercontinental TV signals below the six metre band, as well as work locally above 52MHz. The reflector to driven element spacing is longer than 0.2 wavelengths, to improve the front-to-back ratio over a 0.2 wavelength spacing.

I opted for a gamma match for connection of the feedline. In my experience, on 50MHz antennas it doesn't seem to influence the radiation pattern noticeably. The gamma match can skew the radiation pattern on Yagis built for two metres and higher bands.

For the elements, I chose 12.7mm (1/2″) outside diameter aluminium tubing of approximately 1.6mm wall thickness. But I didn't use that for the complete length of each element. About a quarter of the length, at the ends of each element is 9.5mm (3/8″) outside diameter aluminium tubing, slipped inside the larger tubing.

This arrangement provides a convenient way of adjusting the element lengths. The large diameter tubing has slits cut in the ends, the smaller diameter tubing being secured by a small worm-drive hose clamp. The detail is shown in Fig.2.

If you wish, for a home station antenna, the elements can be made of a continuous length of 12.7mm diameter tubing. However, the ability to adjust the length of the driven element in particular can be handy for tuning up the array, as noted later.

The idea comes straight out of the *ARRL Antenna Book*. It also serves another purpose – allowing convenient 'collapsing' of the antenna to transport it for portable operation. This way, you

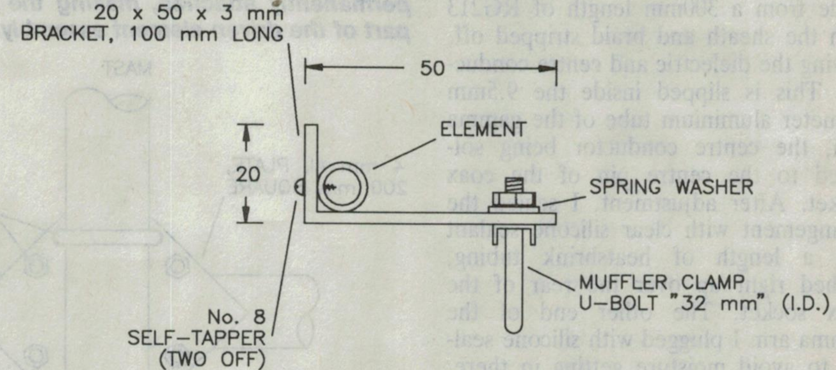


Fig.3: The element-to-boom mount. Each element has a length of aluminium angle section screwed to its centre. The angle section is drilled to take a standard U-bolt muffler clamp, which then secures the assembly to the boom. The author used '32mm' types (this is the inside dimension) because the boom uses 28.6mm o.d. aluminium tubing. They will accommodate tubing the next size up (31.75mm), also.

Simple 6m Beam

can readily fit the collapsed elements on a roof rack without having them overhang. The boom can be 'split' for the same purpose; the method is described later.

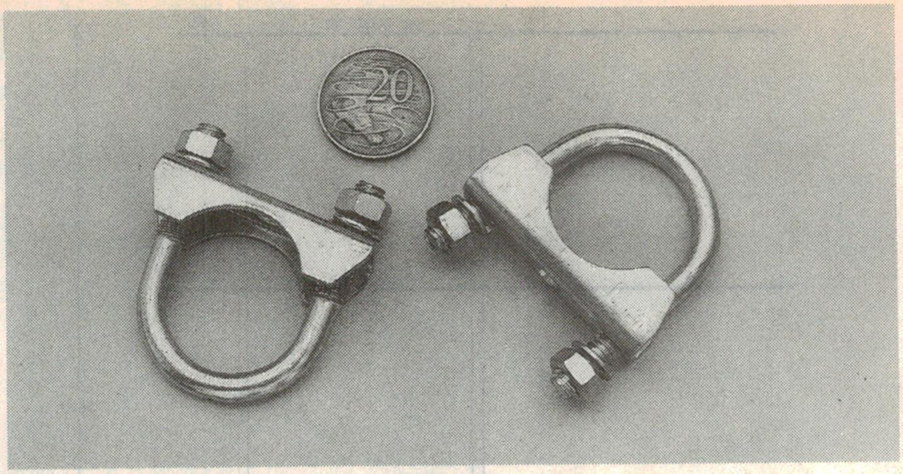
The element-to-boom mounting method I also borrowed from the *ARRL Handbook*. The elements have a length of 20 x 50 x 3mm aluminium angle section screwed to their centre. You could use 50 x 50mm angle section if it's easier to get. Muffler clamps are then used to secure the angle to the boom. Fig.3 and two of the accompanying photographs give the details.

Make sure, when marking out the angle section for the muffler clamp holes, that the two hole centres are parallel to the edge of the bracket. This ensures the elements will be at right angles to the boom. Drilling these holes to give 1-2mm of clearance allows a little leeway for tolerance in the muffler clamps and permits setting the elements at right angles to the boom when they're being mounted.

The boom diameter determines what size muffler clamps to use. A boom diameter of 28.6mm or 31.75mm (o.d.) with 1.6mm wall will adequately support the beam with minimal sag. Heavier wall or larger diameter tubing is unwarranted in terms of its strength, and it costs more.

Details of the gamma match are given in Fig.4. Again, the idea is taken directly from the *ARRL Antenna Book*, although mine doesn't give an illustration for the idea. The scheme is also detailed in Bill Orr's *Radio Handbook*. A 'coaxial' variable matching capacitor is made from a 300mm length of RG213 with the sheath and braid stripped off, leaving the dielectric and centre conductor. This is slipped inside the 9.5mm diameter aluminium tube of the gamma arm, the centre conductor being soldered to the centre pin of the coax socket. After adjustment, I sealed the arrangement with clear silicone sealant and a length of heatshrink tubing, pushed right up over the rear of the coax socket. The other end of the gamma arm I plugged with silicone sealant to avoid moisture getting in there, too.

While I'm talking about plugging things, it's a good idea to plug the ends of the elements, too. This stops them whistling in the wind. A gob of silicone sealant is good for this. For a perma-



Here we see the muffler clamps used in the element-to-boom mounting arrangement. These are '32mm' types. The same size muffler clamps are used in the boom-to-mast mounting.

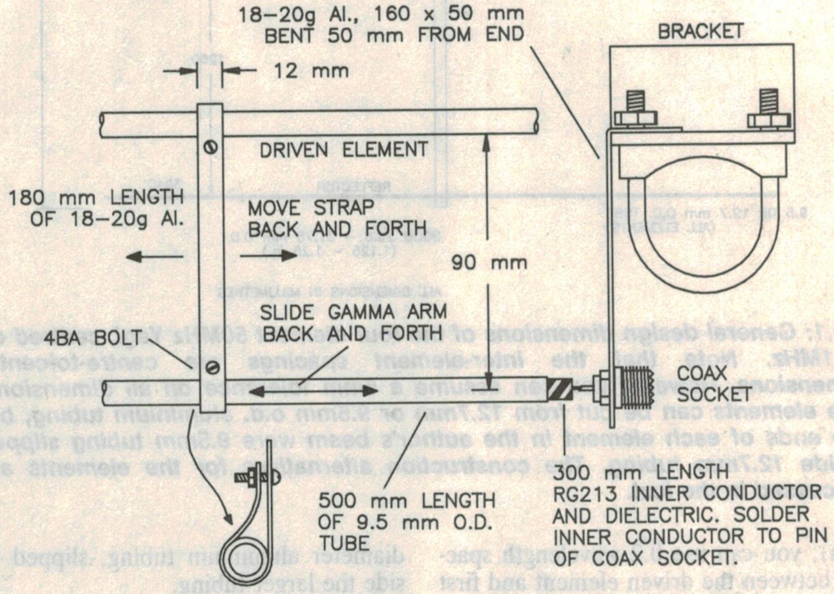


Fig.4: Gamma match construction details. The coax socket is mounted on a length of bent-up aluminium sheet, secured beneath one of the muffler clamp nuts. If yours is to be a portable antenna, this should be screwed to the angle-section bracket with a couple of PK (self-tapping) screws, so that it's permanently attached, making the gamma match and feedpoint an integral part of the driven element assembly.

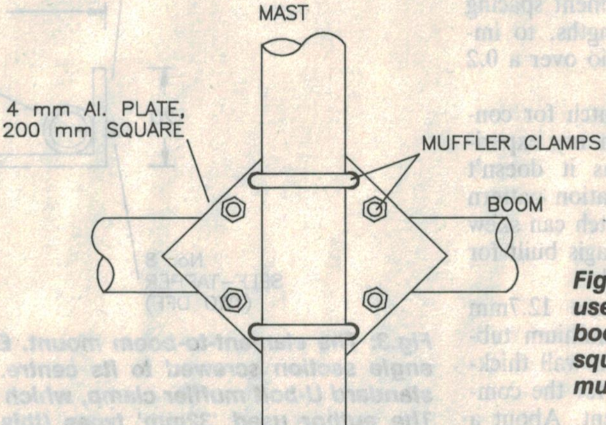


Fig.5: Details of the method used to attach the beam's boom to the mast, using a square plate and four muffler clamps.

Contributed by The Apogee Group

nent, home station installation, clothes-line threaded down the elements will dampen vibration and resonances in them that may be excited by the wind.

There are several ways the boom can be secured to a mast. A simple, practical, scheme is shown in Fig.5. This involves a square of aluminium plate, 200mm on a side. Measure it up carefully so that the boom will be held at right angles to the mast.

For portable use, the boom is best split in the centre and a splice-join fashioned as illustrated in Fig.6. With such an arrangement, only one of the bolts need be undone when the antenna is disassembled for transport.

When assembling your Yagi, ensure that you get the elements at right angles to the boom and parallel to each other. It improves the appearance of the antenna, if not the performance.

Tuning up

The beam can be tuned up and matched by supporting the boom vertically, with the reflector close to, but not on the ground, pointing the antenna straight up at the sky. Make sure there are no power lines or any other metallic structures nearby.

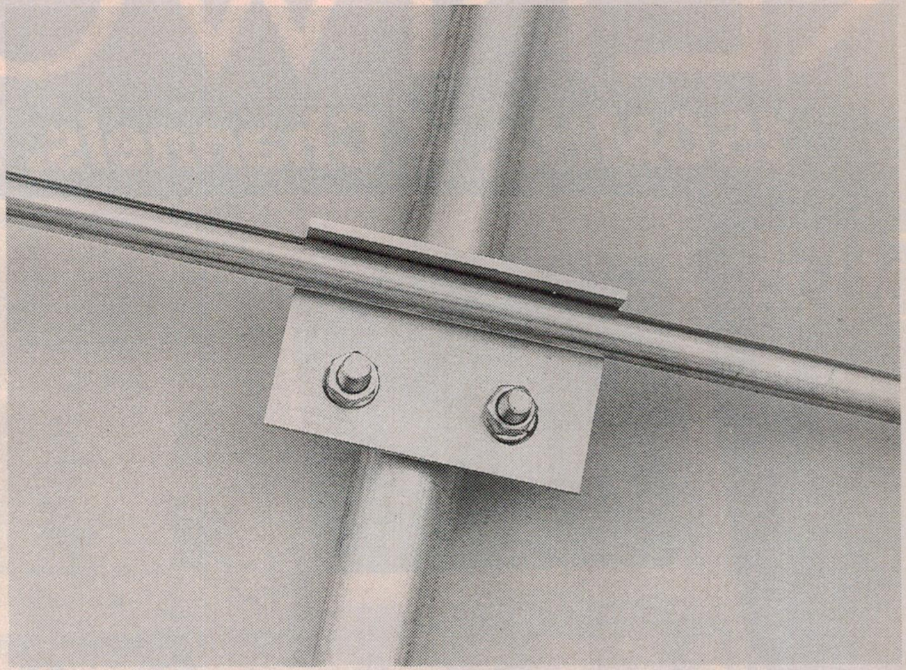
Set the gamma shorting bar about 200mm out from the boom. Connect up an SWR meter close to the antenna with a short length of coax. Make sure that you stand away from the antenna while making measurements.

Check the SWR at 50.1MHz and then adjust the gamma arm. Check the SWR again to see which way it has moved, then adjust either the shorting bar or the gamma arm, or both until you see the SWR decreasing. Note, also, that you can adjust the length of the driven element to get the SWR right down.

Check the SWR again, once you've mounted the antenna. You might want to make a final touch-up, but if the SWR is at a minimum of 1.5:1, or better, around the desired frequency, then leave well enough alone.

To reduce the effects of weathering, I like to coat all the exposed nuts, threads and the tubing joints with a generous smear of petroleum jelly (Vaseline). It saves a lot of effort in the future when maintenance or disassembly is necessary. And that goes for portable beams, too.

There's your beam, and the best of DX to you! •



And here's a closeup view of an element-to-boom mount.

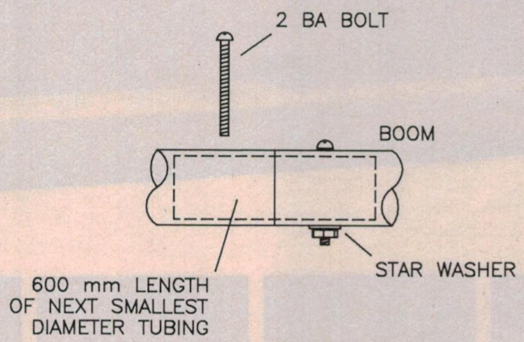


Fig.6: For portable use, the beam can be split in the centre and assembled using this simple 'splice'.

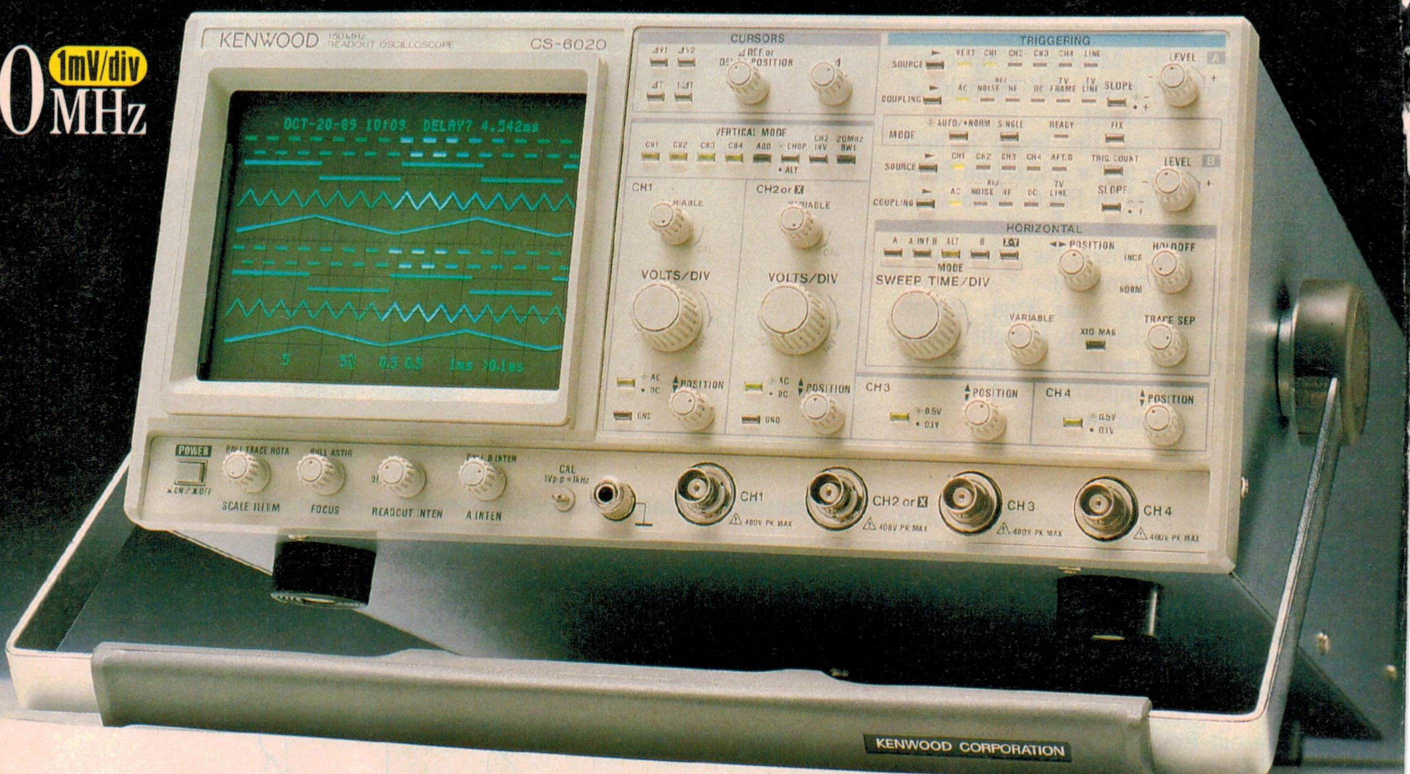
PARTS LIST: ETI-783

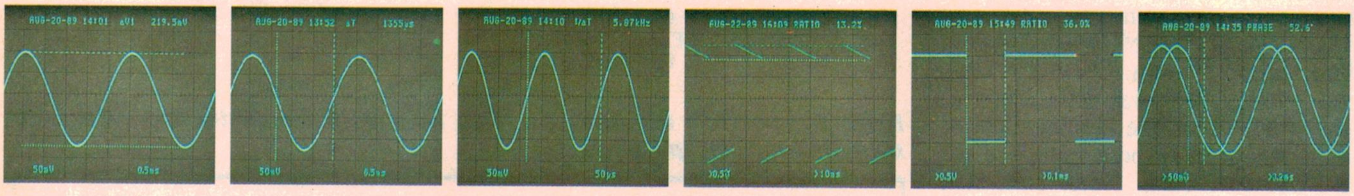
4 x 1600mm lengths of 12.7mm o.d., 1.6mm wall (maximum) aluminium tubing.
4 x 1500mm lengths of 9.5mm o.d., 1.6mm wall aluminium tubing.
1 x 500mm length of 9.5mm o.d. aluminium tubing.
1 x 400mm length of 20 x 50 x 3mm aluminium angle section, cut into four pieces.
6 x '32 mm' muffler clamps, with spring washers.
2 x muffler clamps to suit the mast diameter.
1 x 160mm length of 18-20 gauge aluminium sheet, 50mm wide.
1 x 180-200mm length of 18-20 gauge aluminium sheet, 12mm wide.
1 x 300 mm length of RG213 coax.
1 x coax socket of choice, with mounting hardware.
8 - 10 x No.8 PK screws.
2 x 4BA/12.7mm bolts and nuts, with washers.
8 x small worm-drive hose clamps.
Length of heatshrink tubing, clear silicone sealant, petroleum jelly.

KENWOOD

150MHz, 4 Channels, 10 Traces

150 1mV/div MHz





- Voltage Measurement
- Time Measurement
- Frequency Measurement
- Voltage Ratio Measurement
- Time Ratio Measurement
- Phase Measurement

The CS-6020 has CRT readout functions which provide digital indications of settings such as vertical-axis sensitivity and sweep time on the same screen as the observed waveform, as well as cursor functions which enable digital measurements such as voltage, time, frequency, and phase of displayed waveforms. This makes the CS-6020 a 150-MHz, 4-channel, oscilloscope usable by virtually anyone for waveform measurements and observation. It also has a wide range of advanced features such as trigger counting, cross-range variable, and B sweep variable, and virtually all functions are logic-controlled to ensure excellent reliability and flexibility.

Also new from Kenwood 100 1mV/div MHz

100MHz 4-Channel Oscilloscope
CS-6010

150MHz 4-Channel Oscilloscope
with CRT readout, cursors, and trigger counting

CS-6020

READER INFO No. 23

ELMEASCO Instruments Pty. Ltd.

N.S.W. (02) 736 2888 • **Vic** (03) 879 2322 • **Qld** (07) 875 1444 • **S.A.** (08) 344 9000 • **W.A.** (09) 470 1855

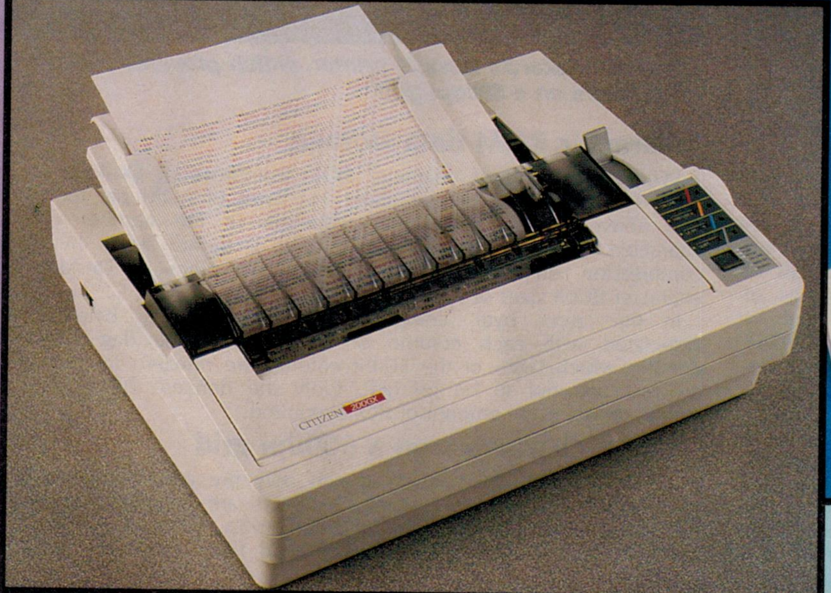
WORKSTATION

EA/ETI'S COMPUTING SUPPLEMENT

Panasonic's new KX-P1124
▼ 24-pin offers 63cps in LQ mode.

▲ Sharp's JX-730 colour ink-jet model offers 180 x 180dpi resolution

Citizen's 200GX 9-pin model
▼ offers 200dpi in both mono & colour



▲ HP's new Laserjet III offers 300dpi and 8 pages/minute, plus HP's Resolution Enhancement

PRINTER TECHNOLOGY FEATURES

From data to dots in HP's Deskjet printer

This story from HP gives a good insight into the kind of processing involved in modern laser and inkjet printers. It describes the system used in the HP Deskjet, where a microprocessor-controlled custom IC manipulates the dot data to provide high resolution and a multiplicity of font variations.

by DONNA MAY, MARK LUND, THOMAS PRITCHARD and CLAUDE NICHOLS

The basic function of the HP DeskJet printer is to transform input data into tiny ink dots on a page. The DeskJet printer offers high-quality characters in a variety of algorithmic character enhancements. As a result, the data must be transformed by a number of processes before being sent to the printhead.

Microprocessor and custom IC

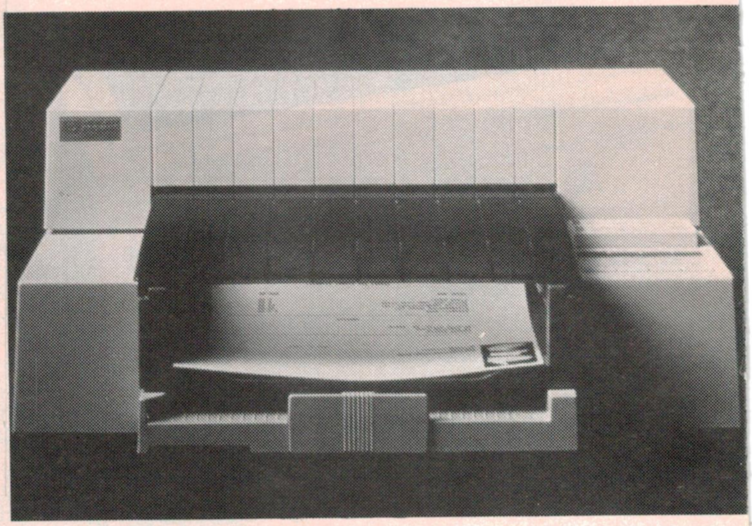
The first few of the processes are performed by a Z80 microprocessor. These processes include receiving the data from the data communications hardware (RS-232-D or parallel), parsing and formatting the data, and translating this data into the form required by the hardware. At this point in the transformation, a custom coprocessor IC determines the pattern of dots to be printed and generates the printhead firing signals required to print the dots.

DeskJet8 character set

The first process of interest in this transformation is the character set mapping. For the DeskJet printer to meet the needs of an international market, it has to support a number of different character sets. These character sets include HP Roman8 (from which 13 ISO substitution character sets can be obtained), PC-8 (IBM character set), PC-8 Denmark/Norway, ECMA-94 Latin 1, and Legal. To maximise the number of character sets that can be stored and formatted, it was decided to combine all of these character sets into a single character set, eliminating all duplicate symbols.

To represent any of the 309 unique symbols in these five sets, 9 bits are required. This is wasteful of precious storage in an 8-bit environment. However, many of the 309 symbols contain a component that can be found in other symbols. Examples of such components include diacritical marks and segments of line-drawing characters. By further reducing the 309 symbols to unique components, it is possible to achieve a symbol set of 256 components, with no symbol reduced to more than two components. The resulting component set, known as DeskJet8, can be used to create any of the 309 symbols.

A symbol that consists of two components is known as a compound character. Special hardware ORs the two components together so they can be printed in a single pass. Thus, any one of the 2240 symbols contained in the 18 character sets can be represented by at most two DeskJet characters. Character set mapping involves determining which character from the DeskJet8 set (or character components, for compound characters), is equivalent to the requested character from the current set (HP Roman8, PC-8, etc.). Because the DeskJet8 set can provide five character sets from one, there are fewer fonts for the user to purchase and fewer fonts to be supported.



Hewlett-Packard's Deskjet printer, which provides 300dpi characters on a 600dpi grid.

Character ROM data storage

Without any sort of character ROM compression, DeskJet8's 2240 symbols would require about 1M bytes of ROM per font. The above-mentioned DeskJet8 reduction in the number of characters actually stored in ROM and a further zeros byte compression on the ROM data result in practical DeskJet character ROM sizes of approximately 30K bytes.

In the 'zeros byte' compression scheme, a flag byte is associated with each column of a character. The flag byte denotes which bytes of the 50-bit column are nonzero (contain at least one dot to be printed). Only the nonzero bytes are stored, reducing the amount of ROM required.

300dpi characters on a 600dpi grid

Although the deskJet printhead can only fire each nozzle at the rate of 300 dots per inch, characters are designed on a horizontal grid of 600dpi. By restricting dots within a row to being at least 1/300" apart, the printhead firing limits are not exceeded.

Fig.1 shows the improvement gained by doubling the horizontal placement opportunities. Some of the algorithmic enhancements, which will be explained later, result in dot patterns with dots only 1/600" apart in a dot row. A cleanup

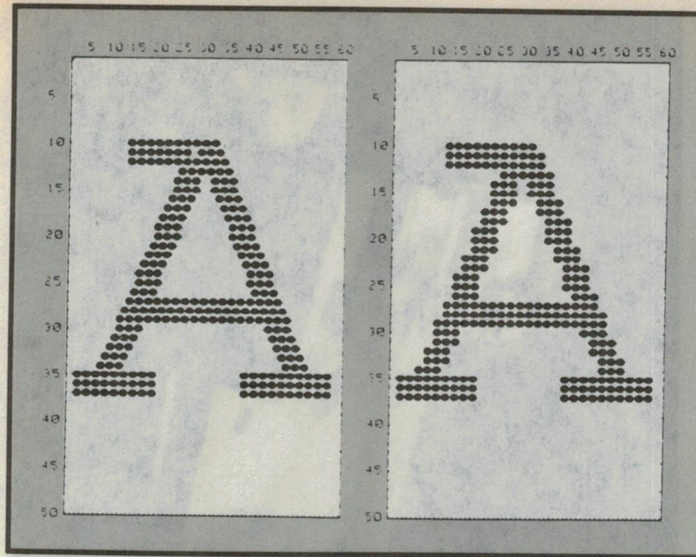


Fig.1: **With dots reduced to make things easier to see, these enlarged letters show how positioning on a 600dpi grid (left) gives a better appearance than on a 300dpi grid (right).**

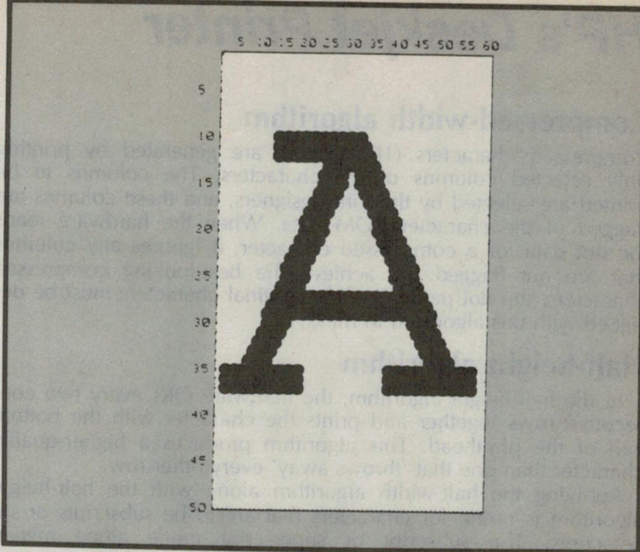


Fig.2: Here is the same character as shown on the left in Fig.1, but with the dots enlarged to normal proportions to show the final appearance.

circuit in the custom IC removes any dots that exceed the limits, since they cannot be fired by the printhead, and even if they could, would result in too much ink on the paper. This dot dropout is performed after all requested enhancements have been applied to the dot pattern.

The dots in Fig.1 are smaller, relative to the character size, than the actual dots. This is to make the dot positions easier to see at the 1/600" spacing. Fig.2 shows the character of Fig.1 with the actual dot-to-character proportions.

Algorithmic enhancements

The link in this process between the firmware and the custom IC is a buffer in RAM, referred to as an image buffer. The firmware translates the character information into the form required by the custom IC and places it into the image buffer. The custom IC accesses the information by direct memory access.

The way in which information is arranged in the image buffer allows the dot data of two separate characters to be ORed together and printed in a single print pass. This feature is used to print compound characters, overstruck characters, and characters that partially overlap. It is also used in the algorithms for half-width and double-width characters.

Double-width algorithm

The simplest way to generate double-width characters is to repeat each column of dots. So a character consisting of columns A, B, and C (1/600" apart) could be printed as AABBCC to double its width. However, the cleanup circuit, which eliminates dots that are too close together, would drop out the second A column, the second B column, and the second C column, since all the dots in these columns are 1/600" away from the identical dots in the previous columns. The result would be the original three columns spaced 1/300" apart, which would typically leave gaps within the character.

The algorithm used in the DeskJet printer takes advantage of the ability to OR two characters in the image buffer together. It ORs the simplest case, AABBCC, with the same pattern shifted by one column:

1/600" →	|	| ←					
	A	A	B	B	C	C	
OR		A	A	B	B	C	C
	A	A	A+B	B	B+C	C	C

The result, after the dot dropout, consists of Column A, the OR of columns A and B, the OR of columns B and C, and column C, all 1/300" apart. This produces a more filled-out character than the simple algorithm.

Hand-width algorithm

Similarly, the easiest way to generate a half-width character is to drop out every other column. The DeskJet printer avoids this loss of data by ORing every two columns together. In the image buffer, this is done by ORing a 'character' that consists of the odd-number columns of the original character with a 'character' consisting of the even-numbered columns.

To illustrate, consider a character with columns A, B, C, D, and E. The odd-number columns, A, C and E, would make up one 'character' and the even-number columns, B and D, the other. The result would be:

	A	C	E
OR	B	D	–
	A+B	C+D	E

By preserving all of the dot data, a higher character can be achieved.

THE DESKJET PRINTER CUSTOM INTEGRATED CIRCUIT

Even a very fast microprocessor would not have the time to perform all of the required character enhancements and other dot manipulations at the 300-dot-per-inch resolution of the DeskJet printer. So instead, a relatively slow, inexpensive, 4MHz Z80 processor is used to control a large custom IC.

Approximately 85% of the logic in the custom IC is there to handle the dot data, as described in the accompanying article. The IC also handles serial and parallel data communications, controls many logic functions required by the paper and carriage motors, provides timer functions to the Z80, and performs several external chip selects.

Contained within an 84-pin plastic leaded chip carrier package is logic laid out as two standard cell blocks, and a large custom 50-bit wide data path corresponding to the 50 nozzles of the printhead. There are approximately 80,000 field effect transistors in a die measuring 6.8 by 7.6 millimetres. A high-density CMOS process is used to fabricate the chip. Gate widths are 1.2 micrometres.

Thanks to excellent design tools and good communications and cooperation among all involved, the first-pass silicon passed the complete set of test vectors without modification, and no turnarounds were required to get the IC into production. The custom IC was totally designed and is currently tested and manufactured within Hewlett-Packard.

HP's Deskjet Printer

Compressed-width algorithm

Compressed characters (16.67-pitch) are generated by printing only selected columns of the characters. The columns to be printed are selected by the font designers, and these columns are flagged in the character ROM data. When the hardware reads the dot data for a compressed character, it ignores any columns that are not flagged. To achieve the best-looking compressed characters, the dot patterns of the original characters must be designed with this algorithm in mind.

Half-height algorithm

In the half-height algorithm, the hardware ORs every two consecutive rows together and prints the character with the bottom half of the printhead. This algorithm produces a higher-quality character than one that 'throws away' every other row.

Applying the half-width algorithm along with the half-height algorithm is useful for characters that are to be subscripts or superscripts. The subscript or superscript mode alone merely causes the characters to be printed 1/12" below or above the text line; the height and width of the characters are not altered. Using the half-width and half-height modes for superscripts and subscripts, the characters appear more balanced in size in relation to the rest of the text.

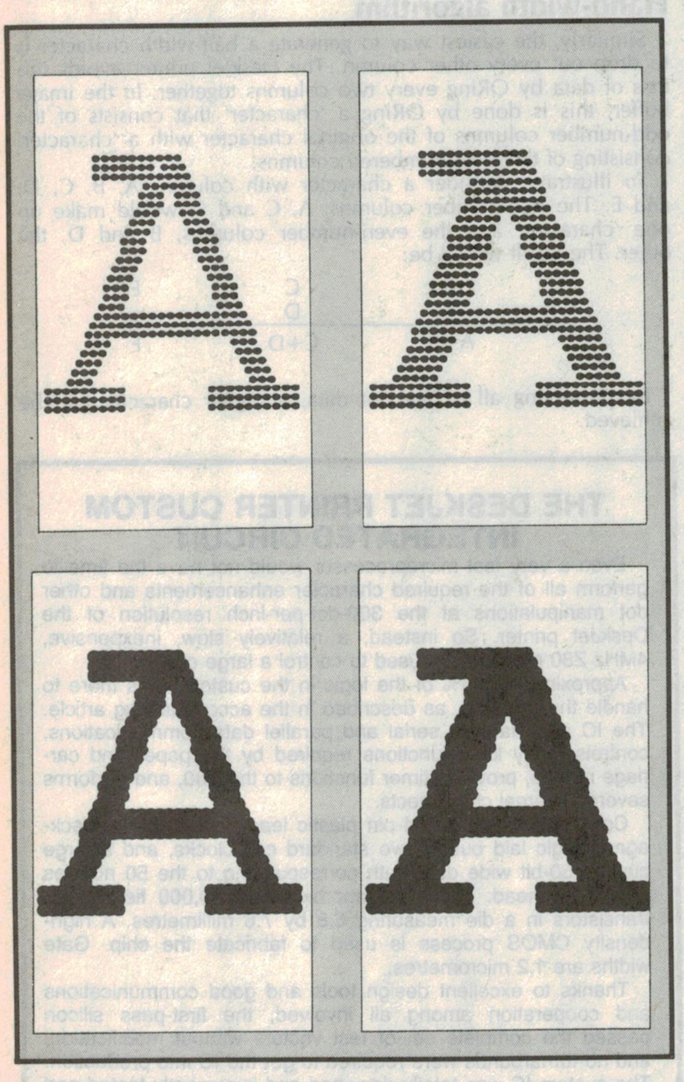
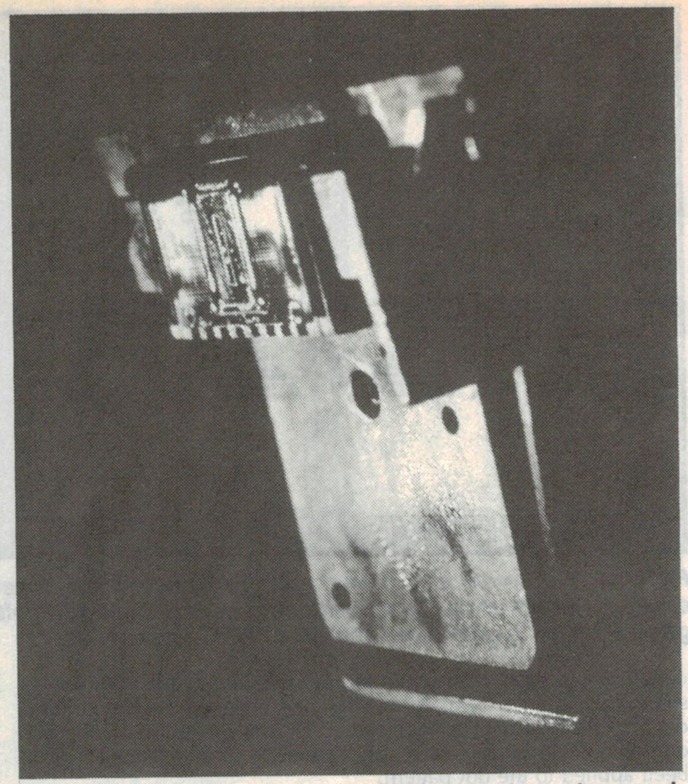


Fig.3: Normal and dark or 'bold' characters. At top the dot size is reduced to show positioning, while below shows the actual appearance.



The HP Deskjet's printhead. There are two staggered columns 1/300" apart, each with 25 firing elements spaced 1/150" apart vertically.

Draft-quality algorithm

The draft-quality mode available on the DeskJet printer doubles the print speed from 120cps to 240cps. In letter-quality mode, 120cps, the character columns are printed 1/600" apart. Since the printhead travels twice as fast in draft-quality mode, the distance between columns is doubled to 1/300". Instead of simply printing every other column of the characters, the hardware ORs every two columns together after any other algorithmic processes have been applied. Besides increasing the throughput, draft mode uses less ink because of the greater distance between columns.

Bold algorithm

The hardware can generate two levels of bold characters. The level to be used is specified in the character ROM for each font, and the firmware communicates this information to the hardware through the image buffer. The lighter bold is used for smaller fonts and the darker bold for larger fonts. For the lighter bold, the hardware adds one dot per row, spaced horizontally at 1/300" to the trailing edge of each character, resulting in a slightly wide and darker-looking character. For the darker bold, the hardware adds two dots instead of one, as shown in Fig.3.

This algorithm produces a result similar to a daisy-wheel printer'; where a character is printed, the horizontal position is moved slightly, and the character is printed again. Because the DeskJet printer is an inkjet printer, multiple-pass printing would put too much ink on the paper. With the DeskJet algorithm, the amount of ink is controlled.

Underlining

Besides containing information about character data, the image buffers can contain auto-underline information. The custom hardware allows the firmware to specify any combination of the bottom 12 nozzles of the printhead to be used for an auto-underline. HP's Printer Command Language (PCL) defines two basic types of underline – fixed and floating.

Floating underlines are specified in the character ROMs on a font-by-font basis. This allows for underlines of the optimum thickness and vertical placement for each font. Fixed underlines are independent of the font used. They provide a uniform under-

line when fonts with different floating underlines are to be underlined with a continuous underline.

Besides being able to select fixed or floating underline type, a user can select single or double underlining. From the user's request and the information in the character ROM, the firmware determines the pattern to be used for the selected underline and communciates this information to the hardware through the image buffer. It also communicates the horizontal positions at which to start and end the underline. The hardware ORs the underline pattern with any character columns that all in the same horizontal region.

Tall fonts

A feature provided by some of the optional font cartridges is tall fonts. These are fonts that have a point size greater than the height of the printhead (12 points). This means that these characters must be printed with two print passes, spearated by a paper advance. All of the algorithmic enhancements described above can be applied to these fonts.

Graphics

Different data manipulation is required for graphics than for text. PCL specifies that graphics data be received in horizontal raster row format, yet the printhead needs data in a vertical column format. This is accommodated by the firmware's rearranging the received bytes and sending them into a custom 8-bit-wide-by-50-bit-high memory array. This array can both shift bytes up and shift 50-bit-high data sideways. Graphics vertical resolutions lower than 300 dots per inch are achieved by repeating data entry into the memory array for multiple rows, causing a vertical expansion of the graphics data. Similarly low horizontal resolutions are achieved by repeating data reads out of the memory array for multiple columns, causing a horizontal expansion.

Printing

Once the firmware has put all the necessary information for a print pass into the image buffer, the printing can be done. The carriage velocity is controlled by the firmware, while a physical position register is updated by signals generated by a position encoder on the carriage motor. The carriage position determines when the columns are to be fired. Columns are typically fired every 139 microseconds.

Printhead considerations

The firing elements on the printhead are arranged in two columns spaced 10/300" apart. The 25 firing elements in each of these columns are spaced 1/150" apart vertically. The two columns are skewed vertically with respect to each other by 1/300", so the result is 50 dots that are 1/300" apart vertically. A 25-bit-wide, 20-bit-long shift register cell is located in the custom IC to delay the firing of the trailing column of firing elements, so that the two columns end up being printed at the same horizontal location.

One final manipulation of the column of data is needed before printing. The printhead is electrically organised as four groups of 12 or 13 resistors. One interconnect pad is used for each firing element and one for each of the banks. This configuration allows only one resistor from each bank to be fired at a time. The custom IC divides the 139-microsecond column time into 13 periods, and fires up to four resistors at a time. The orifice holes on the printhead are slightly staggered from two true columns to account for the positioning error caused by this sequential firing.

Summary

From data to dots, all of this processing provides DeskJet printer users with a wide variety of enhancements that yield high-quality print. From the internal Courier 10-pitch set alone, a user can select one of 18 character sets (including the 13 ISO sets), one of four pitches (normal, half-width, double-width, or compressed), normal or half-height, normal or bold weight, and one of three vertical placements (normal, superscript, or subscript). Since all of these characteristics can be applied in any combination, the internal font alone can be used to generate 864 different fonts. •

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Laser Printer Review:

TI's new 6ppm microLaser

Up until very recently, buying a laser printer with PostScript graphics capability has left very little change from $10,000. But now things are very different: the new Texas Instruments 'microLaser' is available with 1.5Mb of memory and full PostScript as well as HP Laserjet II emulation, for little more than half the above figure. Unlike other models it can also be upgraded easily by the user.

by JIM ROWE

In these days of personal CAD systems and desktop publishing, the trend is towards printers which can produce high-quality graphics images. Ideally this means at least 300dpi (dots per inch) resolution, preferably from a laser printer, and for maximum graphics flexibility it nowadays also tends to mean the ability to cope with *PostScript*, the graphics 'page description language' developed by California-based Adobe Systems.

Unfortunately until a few months ago, laser printers with 300dpi resolution and the ability to print PostScript files have had price tags of around $10,000 - well beyond the reach of most private PC users. But things have changed significantly for the better with the release by Texas Instruments of its compact new 'microLaser' model, available in both basic (HP Laserjet II emulating) and 'PS' (PostScript-capable) versions for $3136 and $5507 respectively, including tax.

Compact as well

The new microLasers are very compact 'desktop' models, measuring only 340mm wide by 360mm deep by 268mm high - including a built-in 250-sheet A4 paper tray. This is because they use a relatively new laser printing mechanism or 'engine' developed by Sharp in Japan, which is somewhat smaller than the Canon engine used by many earlier models.

Like some of the other new compact laser printers based on the Sharp engine, the microLasers operate at 6 pages per minute. This is in theory a little slower than the 8p/m provided by machines based on the Canon engine, but in practice the difference is small enough to be negligible. In any case the speed is often determined by the software you're using, rather than the printer.

To produce the microLasers, TI has combined the basic Sharp engine with its own controller electronics. And fairly nifty electronics it seems to be, too, with a number of features to make the printers rather more 'user friendly' than many previous lasers.

Easy upgrades

A particularly nice feature of the basic microLaser design is that the controller electronics can be upgraded very easily by the user, instead of needing a return trip to the dealer. This is because it's been designed on a modular, plug-in basis.

The complete controller electronics for the basic HPLJ-II emulation model is on a single PC board. This is fitted in a plug-in drawer which slides into the case at the lower rear, being held in place by a pair of knurled-head 'thumbscrews'. The board can be removed at any time (with the power turned off, of course), simply by undoing the screws and sliding it out.

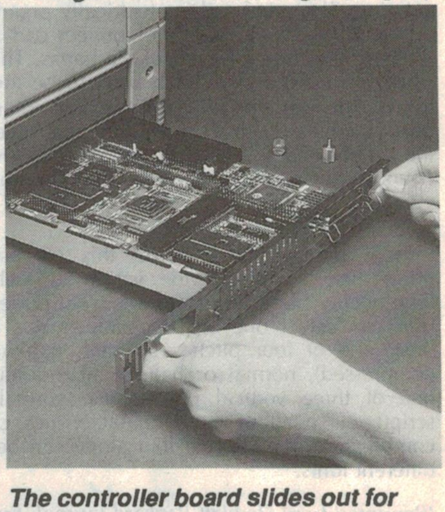
Fitted directly to this slide-out motherboard are the 68000P12 CPU, a set of ROMs with the basic controller software, the laser engine interface, a parallel 'Centronics' communications interface, and 500K bytes of RAM for print file buffering and image assembly. To upgrade from this basic level, you simply plug in additional modules.

For example the standard 'PostScript' model has a RAM module with an additional 1MB of RAM plugged into one of the four available memory expansion positions, plus a somewhat larger module with the necessary PostScript emulation software. Needless to say this means that you can upgrade a 'basic' microLaser to the 'PostScript' model at any time, simply by buying and plugging in the appropriate modules.

(Incidentally the HPLJ-II emulation remains resident when the PostScript module is added, so that the 'PostScript' model can provide either emulation as desired.)

Both the 'basic' and 'PostScript' models can be upgraded to have a total of 4.5MB of RAM, simply by plugging in up to four of the memory expansion modules. Similarly either can be provided with an optional serial interface for either RS232C, RS422 or Appletalk communications - again available as simple plug-in modules.

Like other laser printers, both models have slots for optional additional ROM font cartridges. In this case the cartridges are 'microCartridges', slightly



The controller board slides out for easy user upgrading.

Based on the new Sharp engine, TI's microLaser is very compact - yet it includes an inbuilt 250-sheet A4 paper tray.

larger than a credit card and only about 3mm thick. Cartridges are available with both fixed-size bitmapped fonts for HPLJ-II emulation mode, and scaleable fonts for PostScript emulation mode. Fonts can also be 'downloaded' into the printer's memory from the host system, of course; more about this shortly.

Another aspect of the modular design of the microLaser is the flexible paper feed system. The basic 'default' feed is from the internal 250-sheet cut-sheet feeder tray, which slides in at the lower front. The standard tray supplied in Australia takes common A4 sheets, but trays to take alternative sizes such as B5 and the US 'Letter', 'Legal', 'Executive' and 'Invoice' sizes.

The paper path from the internal tray is basically S-shaped, starting at the bottom in the tray, curving up and around at the front to pass through the laser engine, and then emerging near the rear to curve up and around into the output hopper at the top.

For handling sheets of stouter paper or card which is too stiff to pass around the internal bends, there's an alternative manual feed input slot in the front of the machine above the paper tray. Similarly a small door hinges out at the rear, swinging down to form an alternative output tray and allowing the stiff paper to pass directly through the machine in a completely straight path.

To allow handling a second size or type of paper, there's an optional second 250-sheet paper drawer unit that fits underneath the printer. There's also an optional automatic feeder for envelopes, which clips into the front manual feed input slot. This takes up to 40 typical envelopes, and as these will normally be fairly stiff, the rear output tray is used for them instead of the hopper at the top.

Control facilities

One of the other nice features that TI has built into the microLaser is the ability to program in up to four *personal printer configurations*. These are essentially 'recipes' specifying the emulation (HPLJ-II, PostScript or hex dump), which communications interface is to be used (Centronics/RS232 etc), which paper tray the paper is to be fetched from, and in HPLJ-II emulation whether the printing is to be in portrait or landscape format, how many lines/page, which font and which numeral/symbol set are to be used. Any of these four personal printer configurations can be called up at any time, from the front panel.

The front panel itself has a total of 12 membrane-type keys, plus an 8-character LCD screen and four LED status indicators. Selection of the various possible control modes and options is made via a simple system of hierarchic menues, with 'Select' and 'Up' keys to move between menu levels, and 'Next' and 'Previous' keys to move back and forth within a menu.

The menu system is accessed by pressing the 'Printer Setup' key, whereupon you have a choice of selecting/programming a personal printer configuration, calling for various reports on printer status, or setting up various global function options. In each case, selection drops you down to lower menu levels, where you can set up the desired functions.

Apart from the various options available in the personal printer configurations, the functions available on the microLaser include the ability to print out reports of the printer's overall status, a list of its resident fonts for either emulation, and a report of its hardware configuration and diagnostic status. There's also a 'Help' key, which causes it to print out pages showing the menu trees in various modes.

You can also program it to print up to 99 copies of an incoming file; to power-up in either 'on-line' or 'off-line' mode, as desired; to use any one of eight different default symbol sets; and to reserve a variable proportion of its overall RAM as the file receive buffer. The options for the last of these are 256 bytes, 1KB, 4KB, 16KB, 64KB and 256KB, allowing you to optimise buffer size depending upon operating mode.

Incidentally the microLaser can be programmed to produce its LCD messages and printed reports in four other languages apart from English: French, Italian, German and Spanish.

Another very nice feature of the microLaser is that it keeps track of things like the number of pages you've printed out, toner level and so on, and reminds you when any of the 'expendables' is either nearing exhaustion, or should be replaced.

Expendables - life

For example the toner cartridges last for around 3000 average pages, depending upon the type of material you print. In this case the microLaser keeps track of the toner level, and when this reaches exhaustion it lights the 'Error' LED and indicates that a new cartridge is needed.

On the other hand developer cartridges should last for about 20,000 average pages, or around 7-8 toner cartridges. Here the microLaser allows you to reach 24,000 pages, then displays a warning 'Dvlp Life Over' message on the LCD - but still allows you to proceed, so that you can use up the current toner cartridge. Only when you reach 28,000 pages does it prevent any further printing until the developer cartridge is replaced.

The other remaining printer 'expendable' is the organic photoconductor drum or 'OPC', which should normally be good for about 40,000 or more average pages. Here again the microLaser keeps track of things, and gives you a warning 'OPC Life Over' message if you've printed out a total of 50,000 pages without having any cause to replace the OPC. Then if you ignore the warning (perhaps because the output is still OK), it will finally force you to replace the OPC drum at the 55,000 pages mark. This is the predicted maxi-

mum life of the OPC drum for acceptable quality, so it's not unreasonable.

Incidentally with the microLaser engine rated to print up to about 3000 pages a month, this means that even at this fairly high peak usage level the printer should require toner cartridges no more frequently than one per month. Similarly it should go for about nine months on each developer cartridge, and for up to 18 months before the OPC drum needs to be replaced.

The quoted replacement cost for these items is $91 for the toner cartridge, $247 for the developer cartridge and $259 for the OPC drum (all including tax), so the running costs look as if they should be quite reasonable.

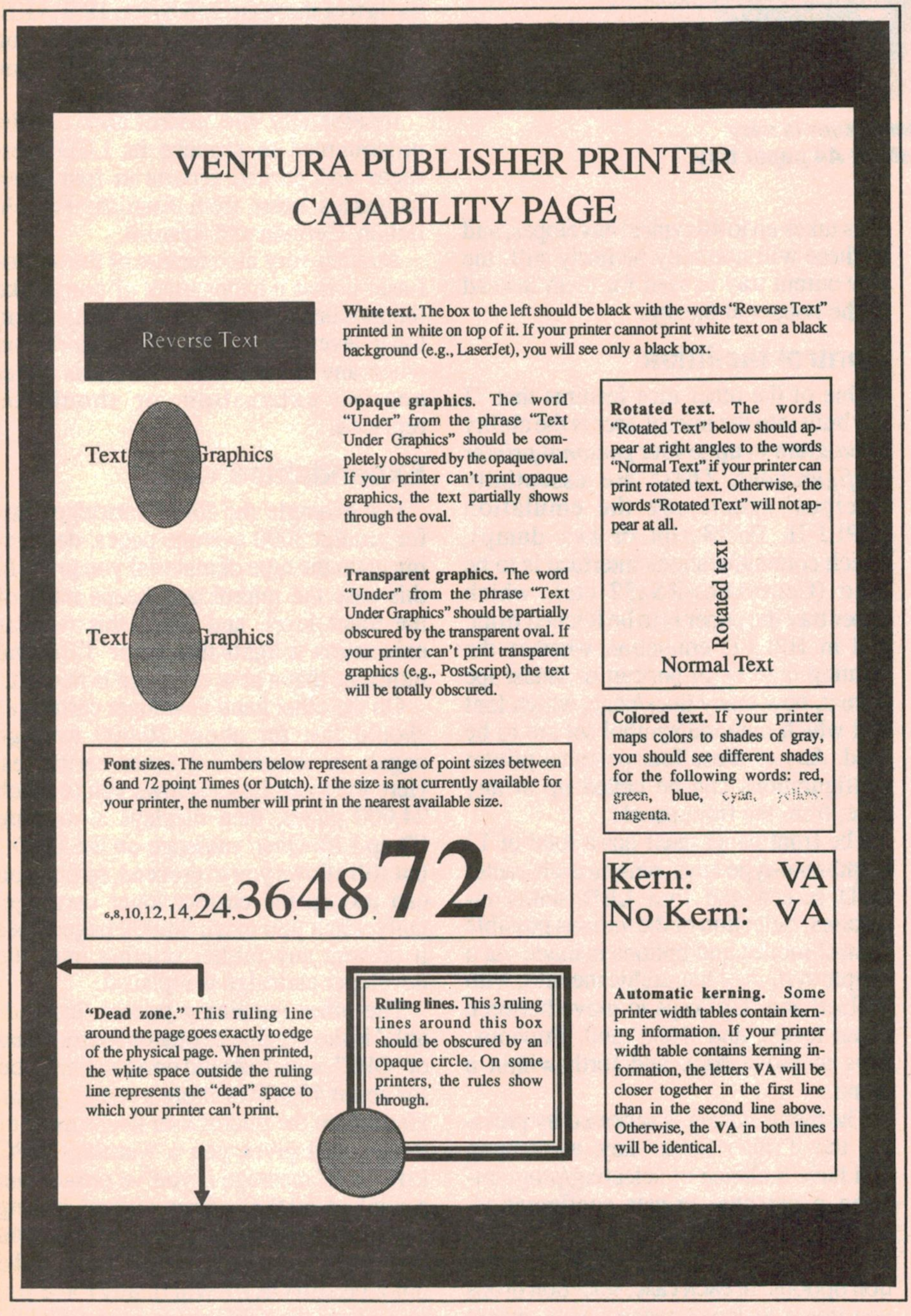
Font selection

In basic HPLJ-II emulation mode, the TI microLaser provides essentially seven resident bit-mapped fonts: Courier 10 pitch (12pt) in Roman, Bold and Italic; Courier 12 pitch (10pt) in the same three variations; and 'Line Printer' - a fairly compact sans-serif font in Roman 16.67 pitch (8.5pt).

If you have the PostScript emulation option fitted, this brings a total of 35 different resident fonts - all scaleable in size from 6pt to 72pt. The fonts are Courier (Medium)/Bold/Oblique/Bold Oblique; Helvetica (Medium)-/Bold/Oblique/Bold Oblique; Times Roman/Bold/Italic/Bold Italic; New Century Schoolbook Roman/Bold/-Italic/Bold Italic; Palatino Roman/Bold/Italic/Bold Italic; Helvetica Narrow Medium/Bold/Italic/Bold Italic; AvantGarde Book/Book Oblique/Demi/Demi Oblique; Zapf Chancery Medium Italic; Zapf Dingbats; and Symbols.

Incidentally, the PostScript emulation fonts aren't available when the printer is operating the HPLJ-II mode, and vice-versa. The two modes are quite independant. So you can't use the 'Line Printer font in PostScript emulation mode, for example - although you can get something very, very close to it by specifying Helvetica Narrow in 8.5pt.

Of course you can always add to the resident fonts in either emulation mode, in two main ways. One is by using the plug-in font cartridges, with additional fonts in ROM; the other is by downloading additional fonts into the printer's RAM, from the host computer. Most of the popular desktop publishing programs are designed to be able to do this, as are some graphics and CAD packages, and the latest versions of many word processors.


VENTURA PUBLISHER PRINTER CAPABILITY PAGE

Reverse Text

White text. The box to the left should be black with the words "Reverse Text" printed in white on top of it. If your printer cannot print white text on a black background (e.g., LaserJet), you will see only a black box.

Text Under Graphics

Opaque graphics. The word "Under" from the phrase "Text Under Graphics" should be completely obscured by the opaque oval. If your printer can't print opaque graphics, the text partially shows through the oval.

Text Under Graphics

Transparent graphics. The word "Under" from the phrase "Text Under Graphics" should be partially obscured by the transparent oval. If your printer can't print transparent graphics (e.g., PostScript), the text will be totally obscured.

Rotated text. The words "Rotated Text" below should appear at right angles to the words "Normal Text" if your printer can print rotated text. Otherwise, the words "Rotated Text" will not appear at all.

Rotated text

Normal Text

Colored text. If your printer maps colors to shades of gray, you should see different shades for the following words: red, green, blue, cyan, yellow, magenta.

Font sizes. The numbers below represent a range of point sizes between 6 and 72 point Times (or Dutch). If the size is not currently available for your printer, the number will print in the nearest available size.

6,8,10,12,14,24,36,48,72

Kern: VA
No Kern: VA

Automatic kerning. Some printer width tables contain kerning information. If your printer width table contains kerning information, the letters VA will be closer together in the first line than in the second line above. Otherwise, the VA in both lines will be identical.

"Dead zone." This ruling line around the page goes exactly to edge of the physical page. When printed, the white space outside the ruling line represents the "dead" space to which your printer can't print.

Ruling lines. This 3 ruling lines around this box should be obscured by an opaque circle. On some printers, the rules show through.

The microLaser's active print area measured 283 x 188mm.

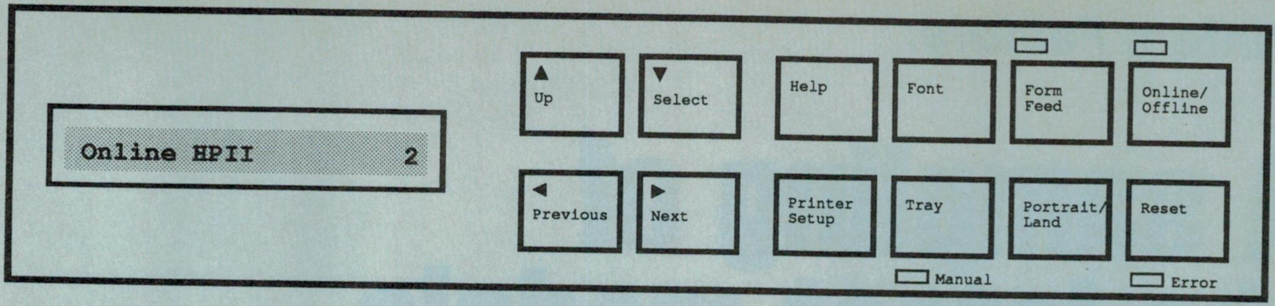
In operation

We assembled the sample TI microLaser, a 'PS' model with 2.5MB of total RAM, and hooked it up to a couple of different systems. Then we drove it with a variety of software packages - word processors, CAD and drawing packages, and both the *Ventura Publisher* and *Pagemaker* desktop publishing systems. Many of the former packages required it to operate in HPLJ-II emulation mode, while the two latter packages used it in PostScript mode.

At the same time, we were able to monitor the performance of two other microLasers - one the same as the review sample, and the other a 'basic' model with only the HPLJ-II emulation and 500KB of RAM. The other units had been purchased privately, by staff members. Basically all three went together without incident (they come in partly knocked-down form, with the 'engine' modules and controller options added by the user), and performed extremely well.

When you turn the microLaser on from cold, it goes through an automatic self-test and fuser warmup cycle, which takes less than a minute. Then if all's well and it's currently in HPLJ-II mode, it simply goes online. Alternatively if it's in PostScript mode, it prints out a status report before going online.

The printing speed is quite good: the first page typically emerges around 16



Up — Pressing the UP switch causes the next higher menu level to appear in the display window.

Select — Pressing the SELECT switch causes the next lower menu level to appear in the display window. If you are at the lowest menu level, pressing the SELECT switch selects the option appearing in the display window.

Help — Pressing the HELP switch prints pages to assist you in using the Control Panel and Setup Menus. Detailed information appears in the User's Manual.

Font — Pressing the FONT switch allows you to change the font selection before printing a document.

Form Feed — Pressing the FORMFEED switch prints any data remaining in printer memory. The indicator above the switch lights when data is in printer memory.

Online/ Offline — Pressing the ONLINE/OFFLINE switch puts the printer Online or Offline. The indicator above the switch lights when the printer is Online (ready to receive data) and flashes when the printer is receiving data.

Previous — Pressing the PREVIOUS switch causes the previous option in the current menu level to appear in the display window.

Next — Pressing the NEXT switch causes the next option in the current menu level to appear in the display window.

Printer Setup — Pressing the PRINTER SETUP switch enters the Setup Menu where you can change the printer configuration, print status reports, and perform many other tasks. Your options appear in the display window.

Tray — Pressing the TRAY switch determines your paper source. All printers give you a choice of Tray 1 and Manual. If you have an optional tray or envelope feeder, these choices also appear in the display window.

Portrait/ Land — Pressing the PORTRAIT/LAND switch allows you to change the page orientation. Portrait orientation prints across the page. Landscape orientation prints down the length of the page.

Reset — Pressing the RESET switch allows you to reset the current software emulation. The error indicator below this switch lights when an error has occurred.

One of the sheets printed out when you press the HELP key, reproduced here at about 80% actual size. Who needs a manual?

seconds after receipt of a file, with subsequent pages every 10 seconds or so. In many cases, we found that the main factor determining overall print speed was not the microLaser itself, but the software producing the printfile. This is particularly true with many CAD and graphics packages...

Print quality was generally fine, with sharp and high contrast 300 x 300dpi images, although occasionally you can get small pale patches evident in graphics images with largish black areas. Whether these are due to small variations in toner 'spreading' or to variations in sensitivity of the OPC drum coating, we couldn't determine; in any case, they're quite minor.

The noise level is very acceptable, being rated at less than 50dBA when printing. In the idling state it's very much lower - basically just the hissing of the small cooling fan.

We found the microLaser's control panel and menu system very easy to operate, particularly after reading TI's well-written user manual. The assembly instructions are also very clear, along with those to guide you in replacing the 'expendables' later on. In fact about the only gripe we could make about the documentation was that there isn't really much material on the PostScript emulation...

Summary

Overall, we found the TI microLaser a very impressive machine. It's compact, it works well and we particularly like the way it's designed for easy user upgrading. For the price, it seems excellent value for money.

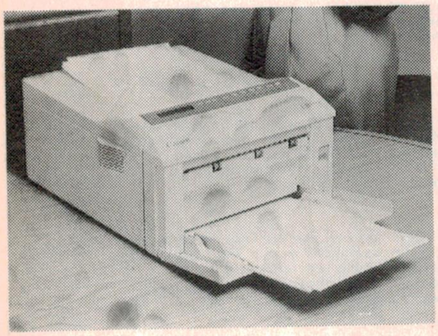
In fact about the only thing we found a little irritating was that in PostScript emulation mode, it doesn't seem to be possible to stop the microLaser from printing out one of its 'Status Report' sheets, every time you turn it on. This is hardly a serious problem, but one that would be nice to have fixed - if only to save paper. Surely it would be better to have the power-up Report optional.

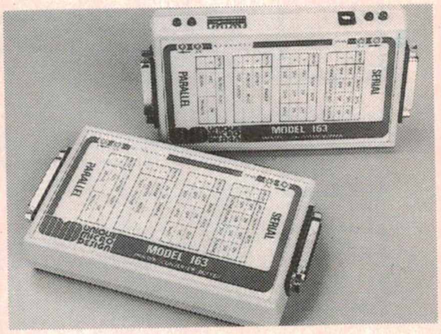
On the whole, though, we were so impressed with the sample unit that we talked the company into buying it, for the *EA* office. So if you've noticed a recent improvement in our PCB etching patterns and schematics, that's why!

We've also been using it to print out our first attempts at desktop publishing. In fact this review itself has been laid out and assembled using *Ventura Publisher*, and printed out on the microLaser PS - just for an experiment. Only the illustrations were scanned in the usual way, and added into 'holes' left in the text; everything else was typeset, laid out, assembled and printed out on the microLaser itself, as complete pages. Did you notice any difference?

For further information on the microLaser, contact either your nearest computer dealer or Texas Instruments Australia, PO Box 106, North Ryde 2113; phone (02) 887 1122.

A sampling of the latest models





LOW COST CANON LASER

The Canon LBP-4 is a small, inexpensive ($2995 RRP), relatively light, 4-pages-a-minute machine capable of being driven by an extensive range of software.

Like its big brother, the LBP-8 III, the LBP-4 uses vector graphics, which means it can print complex images much faster than other laser printers.

Popular software packages ideally suited to the LBP-4 printer include WordPerfect 5.0, Microsoft Word 5.0, Wordstar 5.5, GEM (which can run Ventura), Windows (which can run Pagemaker and Excel), INTO, Lotus, dBase IV, and Harvard Graphics.

Canon is also marketing Forms Designer, a business form-generating package with scalable fonts and ornamentation, exclusively written for CaPSL III, the Canon laser printer controller.

Further details from Canon Australia, 1 Thomas Holt Drive, North Ryde 2113 or phone (02) 887 0166.

ECONOMY 24-PIN FROM PANASONIC

From Panasonic comes the KXP1124, a 24-pin 192cps printer with high performance features at a 9-pin printer price. Features include an 'easy set' operator panel that controls more than 20 functions right up front – no fiddling with DIP switches; and the ability to save and recall printer settings for up to three different applciations.

The versatile paper handling capabilities allow for both portrait and landscape modes with a choice of three paper paths: rear, bottom and front friction feeds. The KXP1124 also sports paper parking, push/pull tractor and zero-inch tear capability to maximise printable area without wasting any paper forms.

The 1124 offers multiple resident fonts including two draft and five letter quality. Over 5500 type styles can be created by combining fonts, character sizes and enhancement modes. The 360 x 360 dots per inch resolution offers crisp print quality, with graphic output rivalling that of any inkjet printer.

Further information from Capital Computer Equipment, 618 St.Kilda Road, Melbourne 3004 or phone (03) 525 2622.

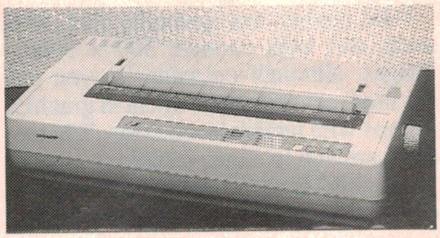
PRINTER BUFFER, DATA CONVERTER

Unique Micro Design has released the model 163 printer converter buffer, which can either convert serially transmitted data into Centronics parallel printer interface format or convert from Centronics parallel printer interface input to serial format. It is a microprocessor based device, which finds use in matching parallel printers to serial interfaces and serial printers to parallel ports.

The device handles the XON/XOFF protocol and provides an optional 8 or 32 kilobyte buffer.

The model 163 is configured via externally accessible switches located on the side of the device. It is powered from a 9V DC plug pack. Incorporated in the device are Printer Test and Monitor Modes. In the Printer Test Mode the device will output test lines to the printer, while in the Monitor Mode the device will output the hexadecimal value of the characters received by it.

Further details from Unique Micro Design, 2/23 Wadhurst Drive, Boronia 3155 or phone (03) 887 1022.



COLOUR INK JET PRINTER

The Sharp JX-730 colour ink jet printer provides 180 x 180 dots per inch resolution and prints in seven colours (black, magenta, yellow, cyan, red, green and violet). Using the Chooser

Level driver in the Macintosh system, up to 16.8 million colours are available to be reproduced.

The ink is held in four separate reservoirs, one for each of the four colours (black, magenta, yellow and cyan). This enables the colours to be replenished separately, thereby reducing the cost per page. The ink jet employs Sharp's advanced 48-nozzle technology to produce the full spectrum of colours used in the printing process.

According to Sharp's National Sales and Marketing Manager, Mr Tony Prince, the JX-730 uses the 'drop-on demand ink jet printing' method. He said the machine can deliver perfect colour quality on paper and transparencies up to 345mm wide.

The print speed is 70cps near letter quality, 140cps in draft format and two minutes per page for graphics.

For further information contact Sharp Corporation of Aust, 1 Huntingwood Drive, Blacktown 2148 or phone (02) 831 9111.

INTELLIGENT PRINTER SHARERS

Diamond Systems has released its new Print Q5500 and Print Q3000 range of intelligent peripheral sharers. An attractive alternative to networking, the Print Q's can perform many of the functions normally provided by a network but at a fraction of the cost.

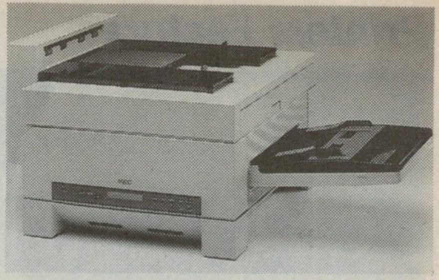
With a Print Q you can integrate your system of PCs, printers, plotters and modem into one easy to use system. Resources such as printers and plotters appear as high speed devices, always available to every user. Background mode file sharing is a breeze on serial models using Diamond's QNET software.

Special input port design allows parallel inputs to run at up to 50KB/sec to distances of 30 metres, using low cost flat ribbon cable. Particular emphasis has been placed on simplicity of installation and use without compromising performance and versatility.

Further information from Diamond Systems, 7 Barreenong Road, Cottles Bridge 3099 or phone (03) 714 8269.

COMPACT 8PPM LASERS FROM NEC

The NEC Silentwriter 2 is a family of eight page-per-minute laser printers designed to print on bond paper stock, en-



velopes, transparencies and labels in either a stand-alone or a networking environment. The printers feature 200-sheet input tray and a manual feed option.

The Silentwriter model 260 offers Hewlett Packard PCL emulation, while the 290 supports Adobe's Postscript page description language. The 290 will work with NEC Powermate systems and the Apple Macintosh range (including Appletalk interface).

The Silentwriter 2 family is based on the latest Canon UX engine, a smaller and more efficient design than previous engines.

The Model 260 is priced at $3200 rrp(ex tax) and the 290 is $7995 rrp (ex tax).

Further details from NEC Information Systems Australia, 99 Nicholson Street, St Leonards 2065 or phone (02) 438 3544.

Electronics Australia

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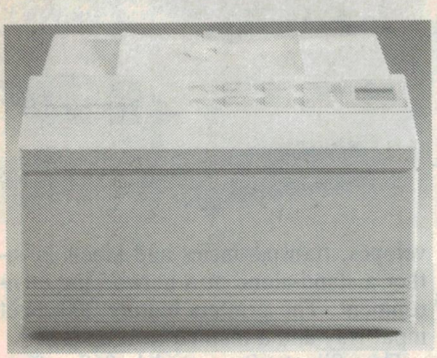
14	39	64	89	114	139	164	189	214	239	264	289
15	40	65	90	115	140	165	190	215	240	265	290
16	41	66	91	116	141	166	191	216	241	266	291
17	42	67	92	117	142	167	192	217	242	267	292
18	43	68	93	118	143	168	193	218	243	268	293
19	44	69	94	119	144	169	194	219	244	269	294
20	45	70	95	120	145	170	195	220	245	270	295
21	46	71	96	121	146	171	196	221	246	271	296
22	47	72	97	122	147	172	197	222	247	272	297
23	48	73	98	123	148	173	198	223	248	273	298
24	49	74	99	124	149	174	199	224	249	274	299
25	50	75	100	125	150	175	200	225	250	275	300



DESKTOP LASERS FROM SIEMENS

The compact desktop laser printer Highprint 7500 prints four pages per minute with a resolution of 300dpi. Siemens rates the printer at a 2500-page volume per month, with printing costs working out to about 5 cents per page. The printer requires little space (40 x 35 x 20cm).

The unit has a modular structure and can be expanded or adapted to match the user's requirements: its basic configuration includes a main memory capacity of 512KB that can be expanded in stages up to 4.5MB, 14 fonts and 24 internal character sets. The number of non-resident fonts or macros that can be loaded subsequently is restricted only by the respective memory capacity, as is the maximum number of fonts per page.

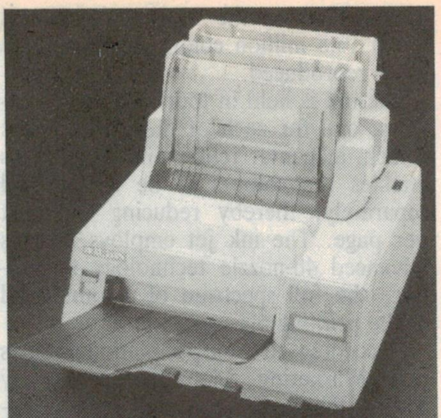
Highprint 7500 has one serial and one parallel interface, operates using the printer language PCL-IV (in its standard configuration) and can emulate other printer languages when equipped with optional cartridges. Siemens offers printer language support for the Epson FX-85, IBM Proprinter III and Abode Postscript. In addition, the user can choose from an extensive library of bit-mapped fonts. All fonts can be reduced or enlarged from 4 to 200 points and supplemented by graphics.

Further details from Siemens Ltd, 544 Church Street, Richmond 3121 or phone (03) 420 7111.

FUJITSU 300DPI LED PRINTER

Fujitsu's RX7100PS is a compact and lightweight 5 page per minute printer offering 300dpi resolution and PostScript emulation, based on LED imaging technology. Recommended average monthly print volume is 3000 pages.

The standard interface on the



RX7100PS is parallel, but RS232, RS422 and AppleTalk serial options are available. HP Laserjet II emulation is supported as well as PostScript, with 35 PostScript fonts and 6 HPLJ-II fonts resident. Three 'IC card' slots are provided for additional fonts, logo's etc. System RAM is 2MB.

Paper feed into the RX7100PS is via two hoppers, with sizes up to 216 x 360mm. Ejection is face-down into a 150-sheet stacker tray.

Further details are available from Practical Peripherals, 333 Pacific Highway, Crows Nest 2065 or phone (02) 956 5133.

Electronics Australia with ETI

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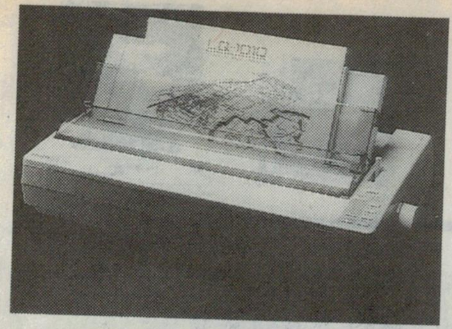


NEW 24-PIN LQ MODEL FROM EPSON

Epson Australia has just released the latest addition to its family of high quality, 24-pin impact dot matrix printers.

The LQ-1010 is an entry-level letter quality printer suitable for either home or office use and priced at around $1000.

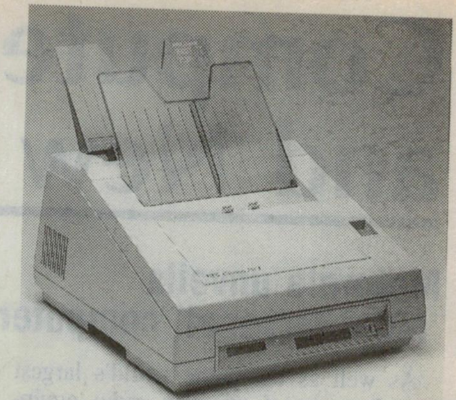
The LQ-1010 has print speeds of 180cps (draft mode) and 60cps (letter quality), advanced paper handling and the ability to print in a variety of type faces on a wide range of paper types.

Able to handle printouts of up to 136 columns wide (or 233 columns in condensed mode), the LQ-1010 also has a 'Smart Park' feature which gives the user the freedom to switch quickly and easily between single sheet and continuous paper. In addition, paper wastage is eliminated because the LQ-1010 automatically advances continuous paper to the next perforated tear-off point, then reversing the paper to the preset top-of-form position as selected by the user.

Two letter quality fonts are available for the production of high quality presentation material and other documents, and the output can be further enhanced by imaginative use of the printer's special effects: emphasised, type, double strike, italics, underline, superscript, subscript, outline, shadow, condensed and double width.

Further details from Epson Australia, 17 Rodborough Road, Frenchs Forest 2086 or phone (02) 452 0666.

POSTSCRIPT COLOUR PRINTER FROM NEC



One of the most versatile printers to be released by NEC, the Colourmate, is a thermal printer which produces full-colour output at the rate of one page per minute.

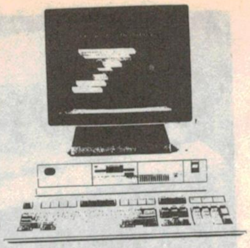
Already supported by applications such as Harvard Graphics, Pagemaker, Freehand, Illustrator and Autocad, the Colourmate will produce colours that comply with the professional Pantone colour set. It offers 8MB of memory as standard and the same choice of interfaces as the Silentwriter 2-290. It can be configured with an optional 20MB hard disk drive for bit-mapped font caching and easy access to stored fonts and forms overlays.

Other features include SCSI interface for 20MB hard disk; Wysiwyg screen drivers; and 300dpi resolution.

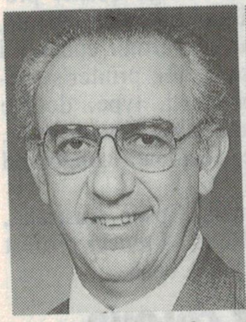
The Colourmate Printer is priced at $15,995 rrp (ex tax).

Further information from NEC Information Systems Australia, 99 Nicholson Street, St.Leonards 2065 or phone (02) 438 3544.

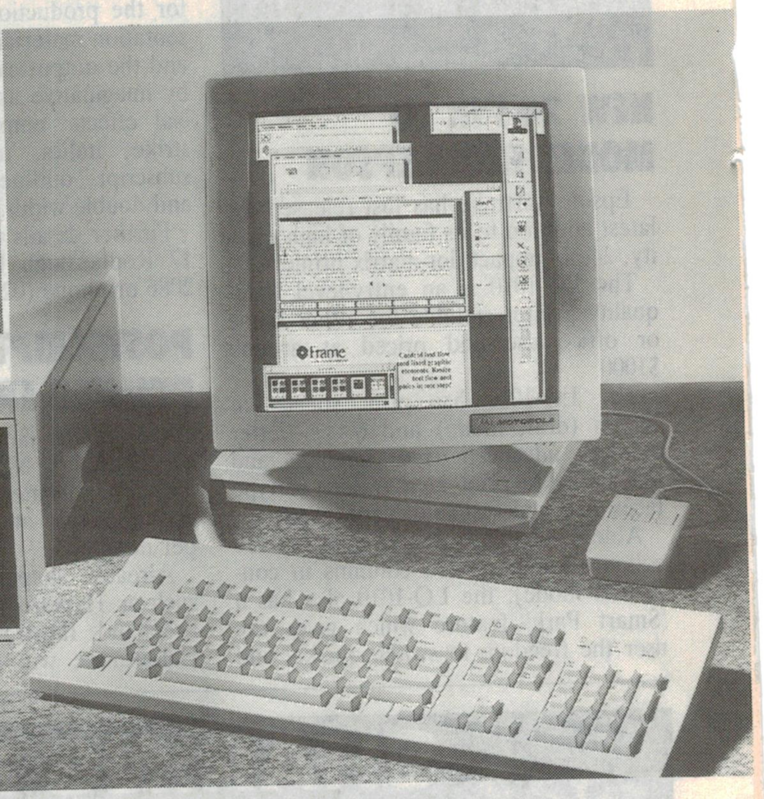
Computer News and New Products



Motorola unveils 'MultiPersonal' computer



Dr Edward Staiano



As well as being the world's largest manufacturer of two-way radio equipment and a leader in semiconductors, Motorola has of course been a leader in microprocessor technology for many years. Its 68000 family of devices have been used in many minicomputers, as well as in the Apple Macintosh personal computer. It also developed the VME-bus system used in many industrial computers. But apart from systems for industrial applications, the company has not ventured into 'business' computers – until now.

This has all changed with the release of the new MultiPersonal Computer family, with which Motorola plans to win a significant slice of the commercial and business computer market worldwide, over the next few years.

The MPC's are basically minicomputer systems based on RISC processors, and running the UNIX operating system. But they use industry standard, non-proprietary open architecture, and provide an easy to use graphic user interface (GUI) with an implementation of the MIT-developed 'X Window' system. This allows them to form what are essentially fileservers, supporting local area networks of PC's and diskless 'X terminals', or what Motorola calls 'Network Display Stations'.

In Sydney for the Australian launch of the MPC's was Dr Edward Staiano, president and GM of Motorola's General Systems Sector, which includes both the Computer and Cellular Systems Groups. Dr Staiano explained that the MPC's have been designed to provide the power and high speed graphics capability of sophisticated workstations, at a cost that makes them highly competitive with existing commercial 'mini' systems. At the same time the GUI and X Windows capability allows them to set new standards of 'user friendliness', and also provides users with the ability to access data via a wide variety of other machines.

The three current MPC models provide performance ranging from 27 to 67.2MIPS, and from three to 32 user stations. They come with Uniplex II Plus, a unified office automation software package; Ethernet, the standard LAN support system; X Window, the hardware-independent graphics environment which gives users concurrent access to multiple applications on multivendor networks; Looking Glass, a desktop manager; and SoftPC, a software emulator that allows the system to run virtually any software application written for MS-DOS PC's, without modification and at speeds comparable with a 12MHz 80286-based PC. They also include a demonstration version of FrameMaker corporate publishing software.

Motorola will also be providing the X-Window diskless high resolution display stations produced by Network Computing Devices (NCD), a Mountain View firm in which it has purchased an interest.

Further details from Motorola Australia, 31 Hume Street, Crows Nest 2065 or phone (02) 906 3855.

PC based 'laser quality' fax

Australian company National Computer Suppliers has released a PC plug-in card which allows a user to send and receive laser resolution quality faxes directly through their IBM or PS/s-compatible personal computers.

Called Quadfax-96, the new product provides many advantages over traditional facsimile machines, yet retails for less than half the price at under $800.

With Quadfax-96, a user can receive faxes from any facsimile machine directly into files on a PC and then view the faxes on the screen, print them on a PC printer, or both.

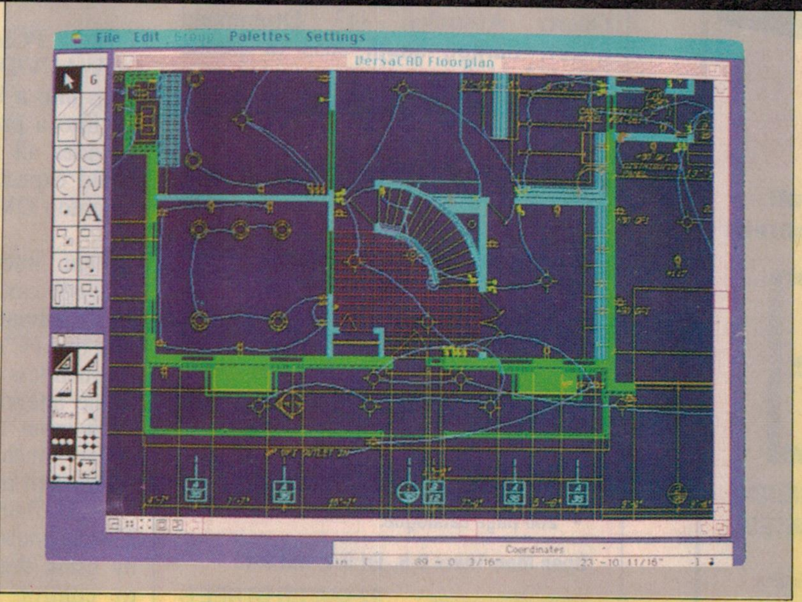
Faxes sent directly with Quadfax-96 have a near-laser printer quality that is substantially better than the image produced from fax machine to fax machine.

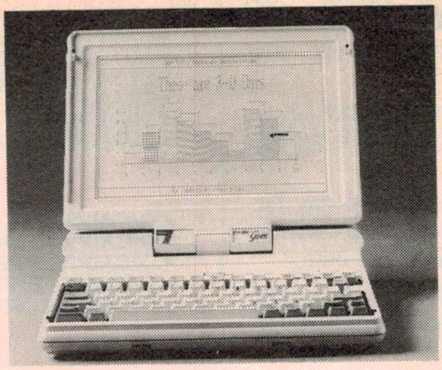
Each Quadfax system – Quadfax-96 for class PC, XT and AT-type computers and Quadfax-96m for PS/2 and compatible systems – include a 9600bps fax modem board.

The software enables transparent background operation, so that a PC can send or receive faxes while the user works with other applications in foreground.

Other features of Quadfax include: a cut and paste facility to merge text and graphics; optional Quadscript module to fax Postscript, HPGL and AutoCad files; a phone book system to store frequently used names, numbers and related information; and delayed transmission facility for off-peak hour faxing.

For further information contact National Computer Suppliers, 2/12 Jesmond Road, Croydon 3136 or phone (03) 725 9111.





Ultralight laptops

Chendai has launched its first two models in a complete new range of ultralight laptop computers. Called the Lap 7 and Lap 8, the innovative notebook-sized computers feature fast V20 and 80386SX processors respectively.

Incorporating a large 10.5" backlit LCD screen, the compact 3.7kg laptops display double-scan CGA in the case of the Lap 7 and brilliant black and white VGA in the case of the Lap 8.

Other benefits include an uncramped, standard sized 77-key keyboard featuring full key travel as found in desktop computers, 640K of memory and a 20MB hard disk in the Lap 7 (2MB of memory and a 40MB hard disk in the Lap 8), optional internal modems and a host of interface connectors for extensive system functionality.

For further information contact Quartz Australia, 113 Drummond Street, Carlton South 3053 or phone (03) 663 6509.

Video and system controller in one chip

The SCC66470 is a fully-integrated 680XX/90CXXX-bus compatible video and system controller (VSC) for fully bit-map video display oriented systems with a resolution of up to 768 x 560 pixels. It is a colour display controller, system controller and image manipulator in one chip.

By using advanced CMOS technology to integrate all the glue logic for a high performance colour display interface, the VSC can replace up to 30 conventional ICs, thereby reducing the number of components required by about 75%.

In addition, the VSC directly controls and refreshes up to 1.5MB of DRAM, arbitrating access between the display controller itself, its refresh circuits, the 68000 bus master, or an external co-processor interface controller. A special function allows the insertion of coloured alphanumeric characters from black and white character fonts located in external memory. The IC also controls the access of up to 0.5MB of system ROM, and 1KB of peripheral I/O space.

For further information contact Philips Components, 11 Waltham Street, Artarmon 2064 or phone (02) 439 3322.

4.5d voltmeter card for PC's

The PCL-860 is a 4.5 digit DCV/ACV/DCR multimeter card that plugs into a PC/XT/AT slot and turns a PC into a programmable instrument. It provides all features and accuracy you would expect from a standard 4.5 digit benchtop DVM, plus the programmability.

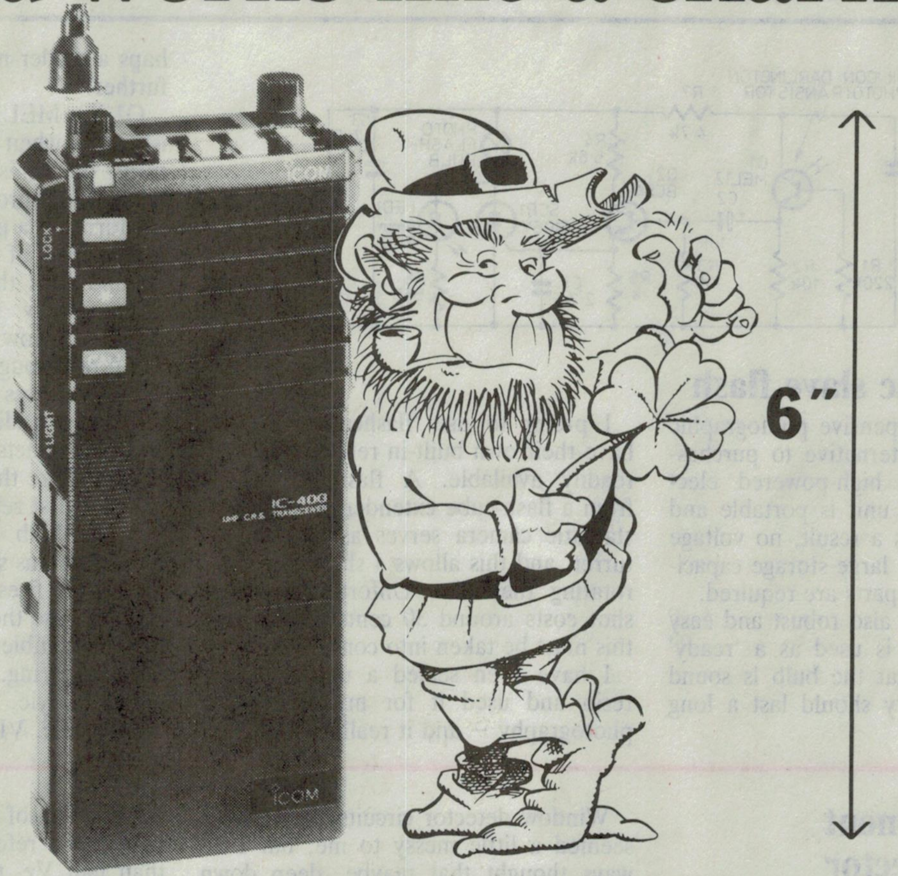
When integrated into a PC system, PCL-860 can be a direct replacement to the combination of an IEEE-488 DVM and the PC's IEEE-488 interface card, at much less cost.

The integrated A/D and the fully isolated input technique used in PCL-860 offers much better measurement accuracy and noise immunity to the user.

Multi-Channel measurement for up to 256 channels can be easily implemented by using the on-board 16-bit D/O port to control external relay multiplexer boards (PCLD-788).

For further information contact Priority Electronics, 23-25 Melrose Street, Sandringham 3191 or phone (03) 521 0266.

What's six inches tall and works like a charm?



the new ICOM IC 40G UHF C.R.S. Transceiver.

Some people think it's magic the way ICOM manage to pack so many features into such a small package. Others think it's a minor miracle that ICOM have simplified operation of the IC 40G without compromising on a wide range of sophisticated functions.

ICOMs high sensitivity receiver and full 5 W output ensures longer-distance communications on all 40 UHF C.R.S. channels. All these features packed into 6 inches of tough, splash resistant construction. Check out the full range of features and options on the new IC 40G at your ICOM stockist – we're sure you'll be charmed.

- Full Scan on all 40 operating channels.
- Dual watch for monitoring channels other than the one you're on.
- 12 memory channels with memory scan.
- Power saver during standby.
- Options include speaker microphones, desk top charger, handsfree headset, battery packs to suit conditions.

ICOM

For further information call ICOM free on 008 338 915

Melbourne callers (03) 529 7582 Icom Australia Pty. Ltd., 7 Duke Street, Windsor 3181.

Icom Australia's warranty is only applicable to products purchased from their authorised Australian Dealers.

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Please rush to me your brochure on the IC-40G and the name of my nearest ICOM stockist.

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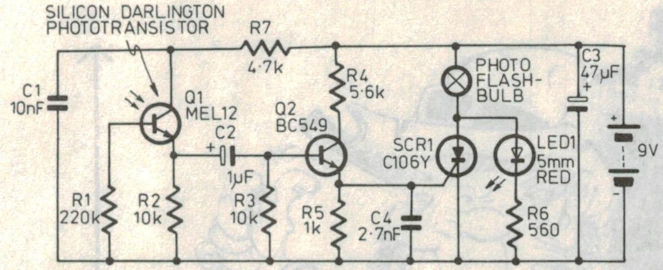
READER INFO No. 31

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide further information.



Photographic slave flash

I made this inexpensive photographic slaveflash as an alternative to purchasing an additional high-powered electronic model. The unit is portable and uses flashbulbs. As a result, no voltage converter circuitry, large storage capacitors or hard-to-get parts are required.

The slaveflash is also robust and easy to build. A LED is used as a 'ready' light, to ensure that the bulb is sound and the 9V battery should last a long time.

I prefer to use 'flashcubes' as they have their own built-in reflector and are readily available. A flashcube socket from a flash-cube extender or an old instamatic camera serves as a mounting turret, and this allows 4 shots by simply rotating the cube. Unfortunately each shot costs around 30 cents a 'pop' and this must be taken into consideration.

I have even sealed a unit in epoxy resin and used it for my underwater photography – and it really works! Perhaps a reader may like to take this idea further.

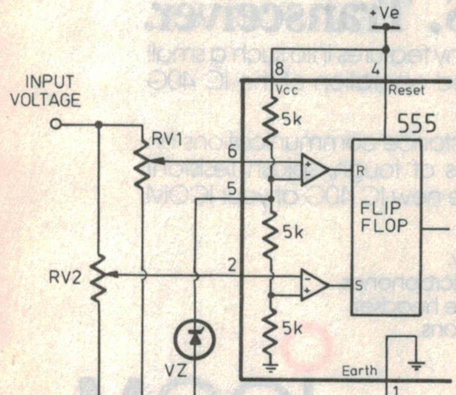
Q1 is a MEL12 darlington phototransistor and when the primary flash fires it turns on. This provides drive to the base of Q2 through capacitor C2. When Q2 turns on a positive voltage is applied to the gate of SCR1, which also turns on and fires the flashbulb virtually instantaneously with the trigger flash. SCR1 will now switch off as no current can flow through the expired bulb.

LED1 serves as a ready light, its current passing directly through the bulb and its contacts. Yet this value is insufficient to fire the bulb.

When first setting the unit up, replace the flashbulb with a miniature 12V globe and this should light when the primary flash fires. Increasing the value of R3 will raise the sensitivity, but be careful that ambient light does not cause false triggering.

Peter Boyle,
Edithvale, VIC. **$40**

Four component window detector



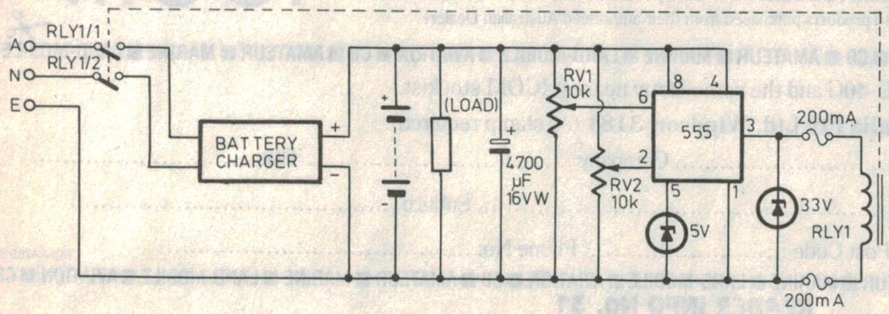
Window detector circuits have always seemed a little messy to me, but I always thought that maybe, deep down inside the 555 timer there may lurk a viable window detector.

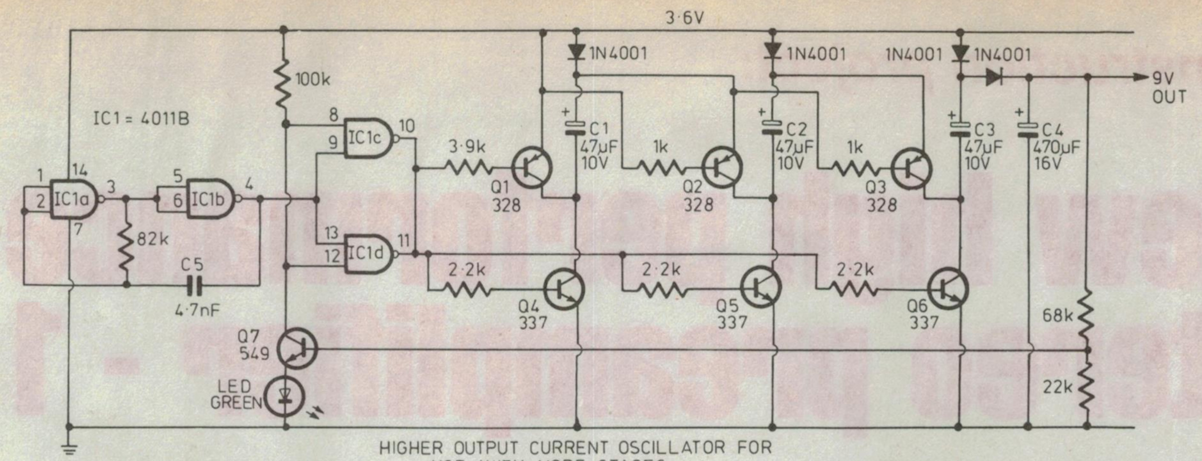
Two years ago I needed something to control a car battery charger unattended for months. The battery feeds a couple of 60W garden lights, controlled by a modified commercial PIR sensor. I like to leave them armed while I'm on holidays. I've always believed that batteries benefit by being cycled more so than floated, so I needed something quick and simple to turn the charger on when the battery voltage dropped to around 12 volts and off again at about 15 volts. The circuit shown (Fig.1) does just that.

A portion of the input voltage is compared to a reference Vz. If Vr2 is less than half Vz, then the flipflop internal to the 555 is set – resulting in a Hi output capable of sourcing 200mA. This Hi will be maintained till Vr1 exceeds Vz. Vz should be less than the upper voltage to be detected. I used 5V as that was what I had. RV1 and RV2 can be any value from 10k to 100k. 10-turn trimpots are best for fine adjustment.

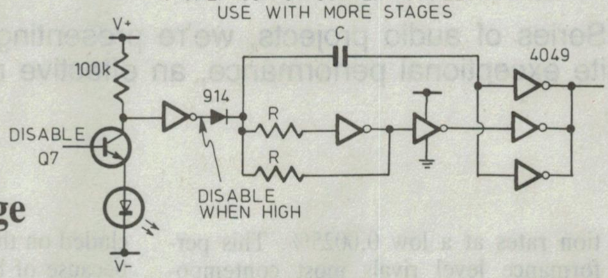
I used the window detector to drive a 12V relay which in turn switched 240V to a cheap commercial 4A automotive battery charger (Fig.2). If the battery is next to the charger then the output of the charger will be well filtered by the battery, but in my case the battery is some distance away connected by about 0.25 ohms of cable, hence the need for the 4700uF capacitor across the output of the charger. Without this filtering the pulsing waveform out of the charger would set and reset the window detector at 100Hz. The 33V zener and the two fuses is a belt and braces approach to 240V safety, and are only for my peace of mind.

Phil Hine,
Raymond Terrace, NSW. **$40**





HIGHER OUTPUT CURRENT OSCILLATOR FOR USE WITH MORE STAGES



'Mosmarx' voltage multiplier

Recently the need arose for an inverter capable of stepping up the voltage from 3 NiCad cells to 9 volts, at currents of up to 50mA. Various options were considered, including the Cockcroft-Walton voltage multiplier, switching regulators and transformer step-up circuits, but the circuit shown here was settled on for reasons of low cost and parts availability.

The circuit works by charging capacitors in parallel and then discharging them in series. Charging occurs when the output of the oscillator built around IC1 is high, which switches on the BC337 transistors. When the oscillator output goes low, Q1 is connected to the positive rail, which caused the positive side of C1 to rise to approximately twice the supply rail. This in turn switched on Q2 and so the sequence continues. The final charge is stored in C4 when the oscillator output is high. The output is regulated by Q7, which disables the oscillator when the output rises above a certain voltage.

As can be seen the series can be continued indefinitely, with voltage multiplication theoretically being Vs (n+1) where n is the number of capacitors and Vs is the supply rail voltage.

Losses are due to the voltage drop across the diodes and the transistors, as well as charge transfer losses. These losses are most significant at low supply voltages: the efficiency of the circuit as shown is only about 55% at 40mA output. However, simply raising the supply voltage to 6V raises the efficiency to 75%, and it can be as high as 90% if Schottky diodes are used.

The value of the 47uF capacitors can be decreased, but the frequency of oscillation, which is fairly critical, needs to be increased. The values of the resistors connected to the bases of Q1 to Q6 are also critical with regards to efficiency. I found the best way to determine the values was to build the circuit up one stage at a time, replacing the resistors with pots.

Note also that driving three stages is about the limit of two CMOSgates. For more stages the circuit using the 4049 buffered output hex inverter should be used.

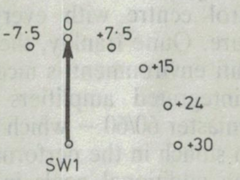
Readers who wish to find out more about the Mosmarx multiplier can consult the August 1988 issue of Wireless World.

James Moxham,
Urrbrae, SA. **$35**

Poor man's variac

When testing electronic equipment it is sometimes necessary to observe the effects of high or low mains voltage.

This circuit allows the mains to be increased or reduced by 30V in steps of about 8V. The secondary of the transformer is inserted in series with the load to buck or boost the voltage, depending on polarity. It uses the popular ARLEC 6672 transformer, which has a multi-tapped 30V/1 amp secondary; this means that the load should be limited to



about 250 watts.

It could also be used with your soldering iron, to give a 'standby' mode when not in use and a 'high-power' mode for heavy jobs.

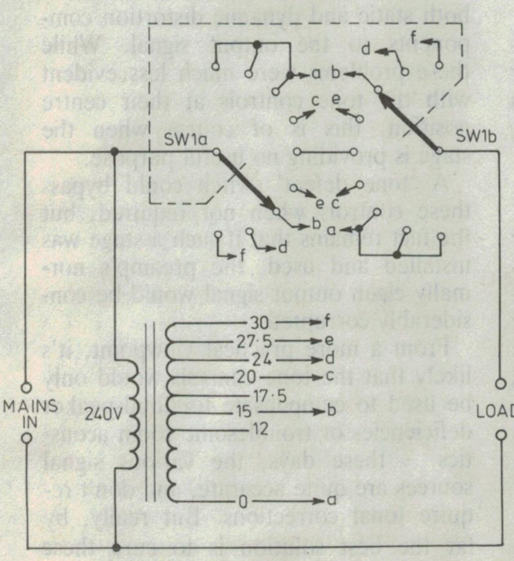
You would want a clockwise rotation of the switch to increase the output voltage but if you find that the switch works backwards, just reverse the connexions to the primary.

Finding a suitable switch is the only problem. Light wafer switches are not good enough for the voltages and currents involved, and the switch should be non-shorting.

The same principle can be used for lots of power control applications. Battery chargers, heaters and even welders come to mind, and of course, there will be none of the RFI problems that phase control circuits are plagued with. The voltage, current and number of steps depend on the transformer used.

Two such circuits could be cascaded to provide coarse and fine control.

'Dr Henry Choke,'
Ringwood, Vic. **$40**



New high performance stereo preamplifier - 1

As the next in our line of Pro Series of audio projects, we're presenting the Pro Series Two control preamplifier. It offers quite exceptional performance, an effective range of features and a simple construction technique.

by ROB EVANS

In the December '89 and January '90 issues of *Electronics Australia* we described the Pro Series One power amplifier; a very high performance MOSFET design capable of delivering more than 140W per channel. Not surprisingly, this has proven to be an extremely popular project, with many readers expressing more than satisfaction with the amp's performance and enquiring as to the availability of a matching preamplifier.

Well, as promised in the January issue, we can finally unveil the Playmaster Pro Series Two preamp – a unit designed to complement the quality of the Pro Series One power amp, and to provide the best possible driving signal for any other power amp with a rated input level of around 1 volt RMS.

We should point out that the extended development time for this project was certainly not due to any hiccups in the basic design, or a mid-stream change of direction on our part. Rather, the months were largely spent *refining* the preamp's circuitry and printed circuit board (PCB) layout, and performing exhaustive practical tests after each change.

That's not to say that the design is at all fussy – it's simply arranged to produce the maximum audio quality from readily available components. You can rest assured that the impressive results are quite repeatable – we've spent the time to make sure.

The final performance is indeed quite exceptional. As shown in the associated specs' table, the signal to noise ratio is better than –105dB under *all* conditions, while the channel separation is a healthy –90dB (at 1kHz) and the distortion rates at a low 0.0025%. This performance level rivals most contemporary CD players, and as was our aim, allows the preamp to behave as the proverbial 'straight piece of wire with gain'.

We should also state from the outset that the concept of this design was to produce a preamp with uncompromised listening performance, rather than a control centre with every conceivable feature. Quite frankly, the more domestic hifi environment is nicely catered for by integrated amplifiers such as our Playmaster 60/60 – which as it happens, is no slouch in the performance stakes.

The additional goals in the development involved the more practical aspects of reliability and ease of construction. Just as in the Pro Series One poweramp, this criteria has been satisfied by a straightforward construction technique with a minimum of interwiring, and a very simple mechanical layout.

By the way, we gratefully acknowledge the assistance provided by Jaycar Electronics, who supplied crucial parts for both the Pro Series Two preamp, and the Pro series One power amp.

Features

In a nutshell, the main features of our new preamp are its performance capabilities. In line with our design philosophy, the unit's audio quality has priority over any extra controls or facilities – as you may have noticed, the bells and whistles have been kept to a minimum. Nevertheless, as spartan as the preamp may appear, the features that *have* been included are really quite useful – and don't incur any performance penalties.

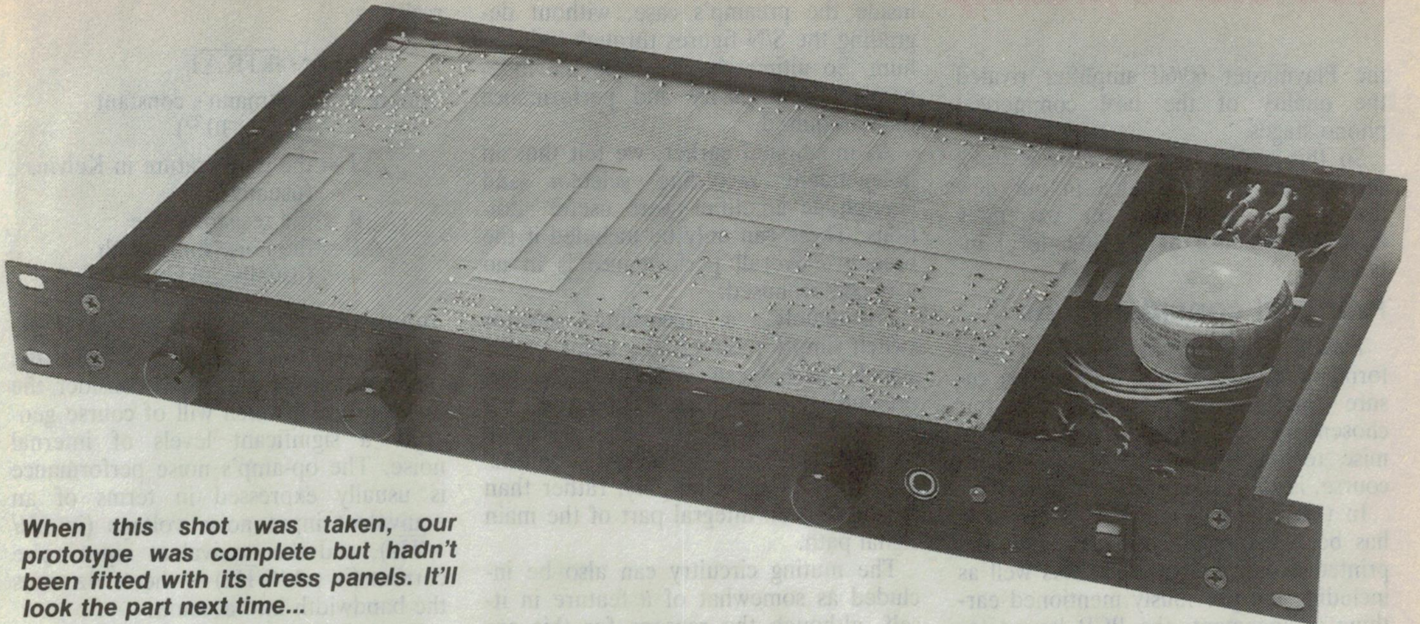
The facilities that have not been included on the other hand, were dropped because of both their inherent performance limitations and questionable usefulness. The most obvious of these are the familiar bass and treble controls.

Since a tone control stage works on active filter techniques employing phase cancellation, we can expect a number of significant anomalies to be introduced as the controls are moved from their centre position. In this condition, the attenuation of the feedback loop is modified in a specific band of frequencies, so as to provide a level of bass/treble boost or cut. We can therefore expect a certain level of increased noise and phase shifts from the circuit, as its frequency response curve is altered from the mean.

This in fact proved to be the case when a test circuit was put through its paces. As well as introducing the above errors, it contributed small levels of both static and dynamic distortion components to the output signal. While these problems were much less evident with the tone controls at their centre position, this is of course when the stage is providing no useful purpose.

A 'tone defeat' switch could bypass these controls when not required, but the fact remains that if such a stage was installed and used, the preamp's normally clean output signal would be considerably corrupted.

From a more practical viewpoint, it's likely that the tone controls would only be used to compensate for loudspeaker deficiencies or troublesome room acoustics – these days, the various signal sources are quite accurate, and don't require tonal corrections. But really, by far the best solution is to cure these



When this shot was taken, our prototype was complete but hadn't been fitted with its dress panels. It'll look the part next time...

problems at their source by using loudspeakers of sufficient quality to match the rest of the system, and experimenting with their positions within the room (we're not really asking you to rebuild your house)...

As a final point, standard tone controls are not very effective at compensating for the complex peaks and dips of loudspeaker/room problems anyway. For a positive effect, a much more sophisticated equaliser is required.

Other than the tone controls, you may have noticed that the usual balance control has also been 'given the bullet' (so to speak). A balance control is rarely used, except for the loudspeaker/-room inconsistencies given above, where the same basic solutions still apply. In the electronic sense, such a control will not affect the preamp's performance while it's in the centre position – providing a special type of potentiometer (M/N) is used. However, as soon as its action attenuates one channel, an appreciable resistance is placed in series with the signal path, and noise is introduced (as discussed later). So a balance control is fine, as long as you don't use it... Out it goes!

On a more positive note, we have elected to include a recording output selector switch (record), as well as the normal source selecting switch (listen). This allows any of the five signals sources to be channeled to the tape output connections, independently of the signal selected for listening. Normally these two functions are combined in one rotary switch, tying the audio output to the source that is being recorded. With a recording switch, you can listen to (say) a CD while taping a radio program – without repatching the signal leads.

We have also added a headphone outlet for private listening. This is driven by a dedicated high performance amplifier, so as to take advantage of the excellent listening quality offered by many of the currently available headphones. The actual signal quality at this outlet is high enough to rival that of the main preamp outputs.

The remaining sections of the front panel feature the volume control (its arrangement is indeed a feature, but more of this later), a mains power switch and two indicator LEDs. The 'on' LED indicates the presence of the internal DC supply, while the 'mute' LED displays the status of the output muting circuit.

Design considerations

To achieve the performance goals of our new preamp, we had to pay particular attention to the type of gain stages used, and less obviously, the manner in which the stages are interconnected.

The earthing technique for example can have a major effect on the channel separation, distortion, power supply interference rejection and general stability of the circuit. To attain the best possible performance in this regard, we elected to use three separate earth paths throughout the preamp.

These are a left signal earth, right signal earth and a general (or 'noisy') earth return. The PCB is arranged so that the left and right signal earths are fully independent until they join at the preamp's main output terminals – where they ultimately connect to a single earth point at the unit's power supply. This main earth point also connects to the general earth path, which (mainly) acts as the return for the various filter/bypassing capacitors scattered around the PCB.

In order to match the earthing requirements of the Pro Series One, and most other power amplifiers, the preamp is fully floating with only the metal case tied to the mains earth. This ensures maximum stability of the combined pair, and avoids the possibility of hum-inducing earth loops.

As a further guarantee of minimum interference between channels, we elected to use single op-amps (NE5534) for the gain stages, rather than the more convenient dual packaged devices such as the NE5532 and LM833. While these offer quite respectable figures for the channel separation between the internal op-amps, two individual devices will inevitably provide better performance in this respect.

Our search for a suitable phono stage took us through a number of designs, ranging from simple op-amp configurations to relatively complex transistor/op-amp hybrids. As it happens, we really didn't need to look any further than the back issues of *Electronics Australia*.

Over the years, a reasonably simple transistor/op-amp circuit has been used to great affect in most Playmaster amplifiers. This arrangement has been progressively developed as higher performance devices became available, to a point where the version appearing in

New stereo preamp

the Playmaster 60/60 amplifier rivaled the quality of the best commercial phono stages.

So this circuit, with its proven track record, has been included in our new design to complement the extremely high performance of the line level inputs.

Practical considerations

Having satisfied the essential performance requirements, we need to ensure that the preamp provides our chosen features *without* any compromise to the audio quality – and of course, is straightforward to build.

In this regard, a great deal of effort has been taken with the design of the printed circuit board (PCB). As well as including the previously mentioned earthing arrangement, the PCB layout totally avoids the use of shielded hookup wire, which has proven to be both unreliable and difficult to terminate. All connectors and gain stages are directly linked via a main PCB, and one small supplementary PCB for the selector switches. Unlike some previous preamp designs, this allows for a very simple construction technique and less chance of performance anomalies.

We also feel that the most practical way to power a preamp is with its own internal mains transformer and associated circuitry. While an external power supply (be it a free standing unit or that of the main power amp) removes the possibility of a nearby transformer inducing hum in the preamp's more sensitive circuits, there are a couple of practical penalties.

Deriving the preamp's power from the poweramp for example means that it's not really an independent unit – it must always be used with a suitably modified poweramp, or some kind of external transformer. On the other hand, a preamp equipped with its own physically separate power supply shouldn't suffer from hum problems, and will be easy to mate to other poweramps. However, the additional expense of another box, connectors and cables makes this avenue difficult to justify – besides, it's messy.

The answer in our case was to follow the path of the Pro Series One poweramp, and use a high quality toroidal mains transformer. These transformers are very efficient (hence cool running), and have a tightly controlled radiation pattern when compared to the more conventional E-core units. This in turn has allowed us to install the transformer inside the preamp's case, without degrading the S/N figures through induced hum. So ultimately, we have the independence, simplicity and performance that's required.

As mentioned earlier, we felt that an independent recording selector and headphone amplifier were useful additions. These can only be included if the preamp's overall performance is in no way compromised.

Fortunately, a recording selector switch simply redirects the input source signals, and doesn't directly affect the preamp's audio path. Similarly, the headphone amp may be arranged as an independent unit (which only 'monitors' the preamp's main output), rather than included as an integral part of the main signal path.

The muting circuitry can also be included as somewhat of a feature in itself, although the reasons for this are not all that obvious. While most designs offer a muting circuit to disconnect the audio output for a couple of seconds during power-up, they disengage in a relatively slow fashion. We've taken steps to correct this shortcoming with a relatively sophisticated muting circuit.

To understand the usual muting problem, imagine that the preamp has been on for some time, and then the power is turned off and on in rapid succession – if you accidentally turn the unit off for example, the instinct is to quickly switch it on again. This invariably produces a loud thump from the speakers as the preamp circuits begin to shut down, and are quickly re-energised. The average typical muting circuit (due to its simple design) will not disconnect the audio output quickly enough to stop any transient signals being passed to the poweramp.

To ensure a failsafe muting cycle, the control circuit in our new preamp senses the AC supply voltage quite directly, and shuts off the audio output within a few milliseconds of the supply being removed. The actual muting is performed by the contacts of a standard relay rather than an active switching device (such as a transistor or FET), which can introduce subtle forms of distortion as their parameters vary with the applied signal voltage.

Noise and op-amps

During the development of almost any op-amp stage, its final signal to noise ratio can be calculated with quite reasonable accuracy. This is possible by use of a little basic circuit analysis, and the equation for thermal noise in resistors:

$$En = \sqrt{4kTR\triangle F}$$

where k = Boltzmann's constant (1.38×10^{-23})
T = the temperature in Kelvins (usually 298)
R = the resistor value
$\triangle F$ = the noise bandwidth (usually 20kHz)

While this allows us to calculate the noise contributed by the resistors in the signal path, we must also consider the op-amp itself, which will of course generate a significant levels of internal noise. The op-amp's noise performance is usually expressed in terms of an equivalent input noise voltage (in $nV/\sqrt{Hz}$), and the equivalent input noise current (in $pA/\sqrt{Hz}$) – the $\sqrt{Hz}$ takes the bandwidth into account.

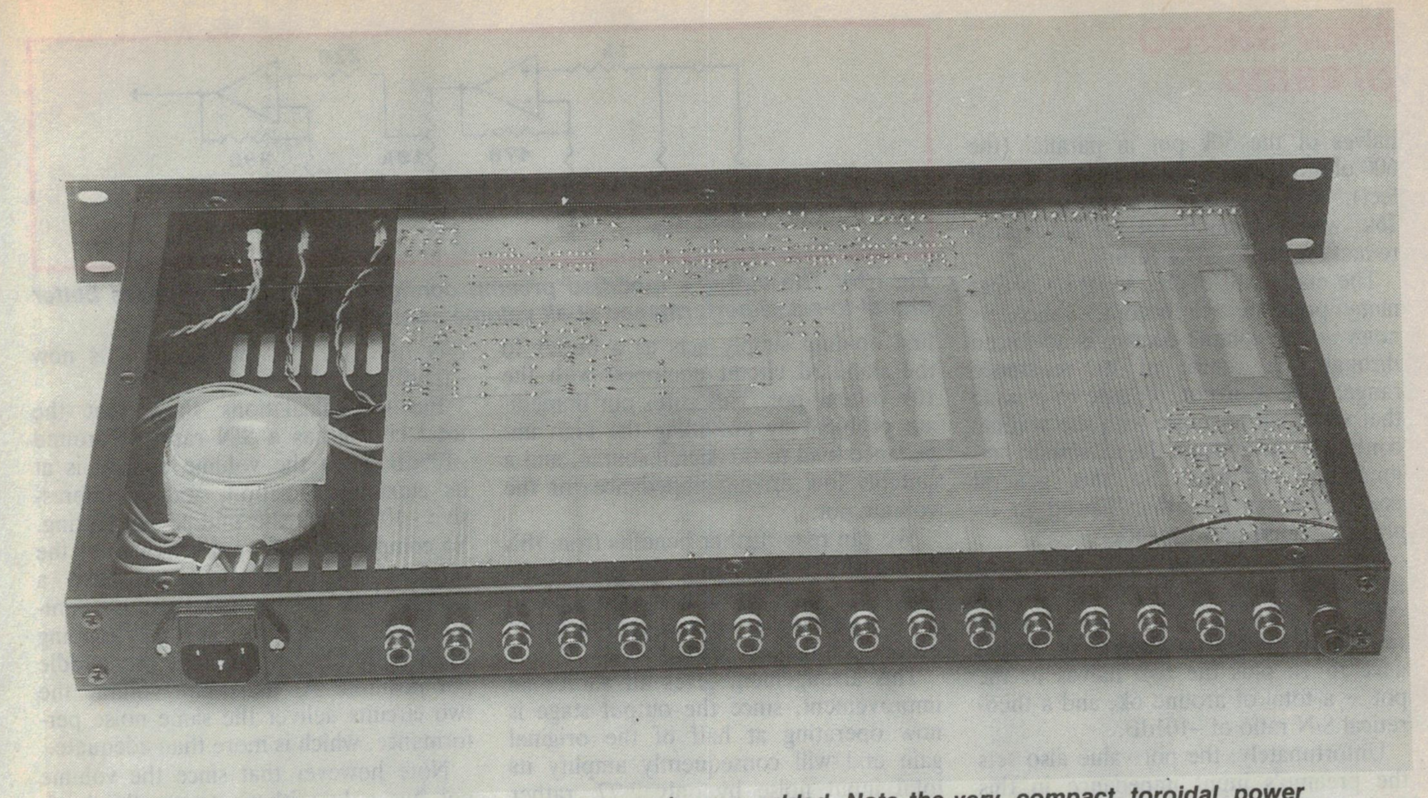
So to find the total noise level at the op-amp's input, we calculate the noise generated by any resistors in the signal path, and (vectorially) add this to the op-amp's overall equivalent input noise. The figure is then multiplied by the gain of the stage for a final estimation of the output noise. For a more detailed description, see 'Estimating noise in op-amp stages' which appeared in the April 1987 issue of *EA*.

In general then, we can achieve best overall noise performance by using an op-amp with a very low input noise figure, and the smallest possible resistors in the signal path (including the feedback network). However, there are of course a number of practical limitations when choosing these components.

The resistors that will directly affect the noise performance of a stage can be broadly divided into two groups – those which lie in the direct signal path (the op-amp's actual input resistor, and the internal resistance of the signal source), and the resistors in the feedback loop (used to set the op-amp's overall gain).

Unfortunately, the first group is often out of our control, since the input resistor will often define the input impedance of the stage and may need to be quite high. Also, the components which set the internal impedance of the signal source (in fact, its output impedance) are usually inaccessible. However most hifi signal sources (such as CD players) are typically less than 1k ohm, which is not too much of a problem.

The second group of resistors on the other hand, may be selected for the lowest possible value with only one major constraint. Since the feedback network offers a direct load to the out-



Another shot of our prototype before the dress panels were added. Note the very compact toroidal power transformer, and the lack of complex hand wiring.

put of the op-amp, the minimum total resistance of the network is limited by the drive capabilities of the device itself. Most op-amps will only deliver full performance into loads of at least 1k ohm – this of course includes both the feedback network *and* any load outside the actual stage.

So the options for minimising noise in an audio gain stage are really quite limited, due to the conditions around the circuit and the op-amp itself. However, a number of the above effects will be significantly reduced if we choose a device such as the NE5534AN.

This op-amp offers an equivalent input noise voltage of only $3.5nV/\sqrt{Hz}$, and the capability to deliver its full output swing into a 600 ohm load. And as a bonus, the NE5534AN has excellent supply rejection and distortion figures (typically less than 0.003% THD). However as mentioned above, its noise performance in particular will depend upon the actual circuit configuration.

Hidden noise

The main circuit used in most audio preamplifiers is really quite a simple arrangement. After all, the basic requirements are to boost the input signal level to that of the power amp's sensitivity, and to offer a relatively high input resistance and low output impedance. These conditions are quite easily satisfied by a simple non-inverting op-amp stage with a gain of 5 or 6, and an input terminating resistor of 47k. So for a working preamplifier, we simply replace this resistor with a volume pot (of a similar value) and include an input switching network to select the various signal sources.

This appears in a simplified form in Fig.1a, which represents the basic arrangement of most preamps. In this circuit, we've shown the input terminated (externally) in a 600 ohm resistor for the purposes of noise measurement, and the usual 'stopper' resistor (1k ohm) in series with the op-amp's non-inverting input. Assuming that the device is a 5534, the feedback resistors can be set to the lowest practical value for minimum noise (in this case, a total of 620 ohms) while maintaining a gain of 5.6. Finally, the 50k pot acts as a volume control and defines the circuit's input impedance.

Now as it stands, this arrangement is capable of very high performance. Thanks to the 5534, the signal to noise (S/N) ratio weighs-in at a theoretical –106dB (relative to a 1V RMS output level) with the volume control at its maximum position. On test, this figure was confirmed, and the distortion measured at around 0.002%.

With the volume control at its *minimum* position on the other hand, the S/N ratio is shown to be around –107dB. The slight difference between the figures for the minimum and maximum volume positions are due to the change of input resistance for each position. That is, when the pot's wiper is at the bottom of its travel the input resistance is set by the 1k resistor, whereas at the top position it becomes the 1k resistor plus the 600 ohm resistor in parallel with the 50k pot – a total of about 1.6k.

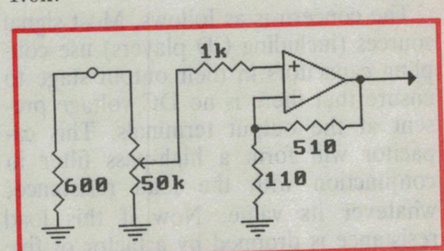


Fig.1(a): The circuit of most conventional hifi preamps can be reduced to this basic arrangement, for 'line' inputs.

All in all, the above noise figures are quite encouraging, and compare well to the specifications for most CD players. However, if we take the analysis one step further and calculate the S/N ratio with the wiper at its *middle* position, we arrive at a figure of only –94dB – some 12dB short of the figures for the extreme wiper positions. As can be seen from Fig.1a, the input path is now formed by the 1k resistor plus the two

New stereo preamp

halves of the 50k pot in parallel (the 600 ohm resistor is small enough to neglect). This produces a total of around 26k, which accounts for the substantial reduction in the S/N figure.

The end result of this situation is that many preamps will become noticeably noisy as the volume control is advanced through the centre of its resistance range. Like it or not, it's safe to assume that we listen to music with the volume control set away from the maximum and minimum positions! So this general preamp design is rather flawed in its *practical* noise performance.

The immediate answer to this problem might be to simply drop the pot value to say 10k, which would in turn reduce the middle position input resistance to 1k plus the two halves of the pot – a total of around 6k, and a theoretical S/N ratio of –101dB.

Unfortunately, the pot value also sets the preamp's input impedance in this design, which would consequently drop from the standard value of 50k to only 10k. But would this be a problem?

Since most signal sources have a reasonably low output impedance (say less than 2k), the above change should only drop the incoming signal level by less than 2dB – since we are dealing with a 2k/10k voltage divider. However due to the increased load, there is no guarantee that the source's low-frequency roll-off point is maintained at a satisfactory level.

The concern is as follows. Most signal sources (including CD players) use coupling capacitors in their output stage to ensure that there is no DC voltage present at the output terminals. This capacitor will form a high-pass filter in conjunction with the load resistance, whatever its value. Now if this load resistance is dropped by a factor of five (as in our case), the low-frequency roll-off point *must* increase by the same factor.

In practical terms, this means that if the source has a respectable –3dB point of say 15Hz for the standard load resistance (50k), then the reduced load (10k) will raise this point to 75Hz – not really an acceptable compromise. On the other hand, the output capacitor may be large enough to cope with the abnormal load, causing the cut-off point to rise from (say) 2Hz to 10Hz. Nevertheless, we don't feel it's worth the risk.

Fig.1b shows a circuit developed to correct the problem. In essence, the

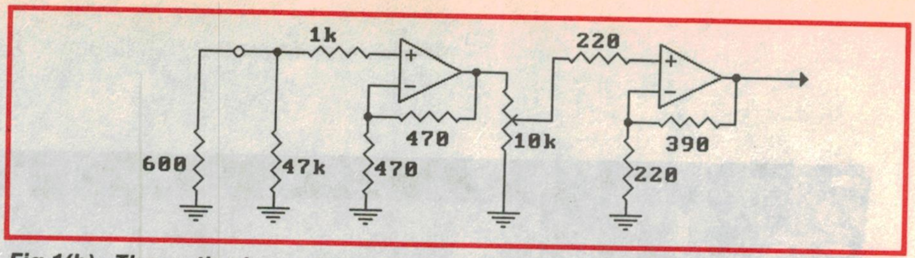


Fig.1(b): The author's modified preamp configuration, which achieves better signal-to-noise performance at all volume control settings.

first op-amp simply acts as a buffer to the standard circuit equipped with the 10k volume pot. This cures our immediate problem by providing the high impedance load to the signal source, and a suitably low driving impedance for the volume pot.

We can reap further benefits from this configuration by setting the gain of the first stage at 2, and the second stage at 2.77 – yielding an overall gain factor of around 5.6 (as before).

This arrangement gives an additional improvement, since the output stage is now operating at half of the original gain and will consequently amplify its total input noise by only 2.77, rather than 5.6. This in turn offers a significant benefit when the volume control is at its minimum position – that is, when the noise from the first stage is not passed to the second. In fact, the theoretical S/N ratio for this pot position is now –116dB.

Further calculations show that the total circuit has a S/N ratio of around –106dB when the volume control is at its maximum position, and an impressive –107dB for the middle pot setting. So compared to the noise figures of the original circuit (Fig.1a), we have a healthy 9dB improvement at the minimum volume setting, and a whopping 13dB reduction in noise at the middle pot position. At maximum volume the two circuits deliver the same noise performance, which is more than adequate.

Note however that since the volume pot has a logarithmic taper, the knob pointer will be positioned at about 3 o'clock for our half resistance value. This is in fact where the noise will peak in the standard circuit.

So if we assume that most listening is

SPECIFICATIONS

Signal to noise ratio (20kHz bandwidth, unweighted, ref: output level of 1V RMS)		
Line level inputs:	Minimum volume	–115dB
	Mid volume	–106dB
	Maximum volume	–105dB
	Typically	–109dB
		(–112dB ref: 1.5V RMS)
Phono input:	1kHz, 10mV input	–89dB (1k source)
cf34Channel separation (20kHz bandwidth, with respect to 1VRMS output level)	1kHz signal	–90dB (1k source)
	10kHz signal	–71dB (1k source)
Harmonic distortion (20kHz bandwidth, typical load)		
Main output:	At 1VRMS	0.002%
	at 5VRMS	0.002%
Headphone output:	Below clipping	0.002% (8 ohm load)
Input and output levels	Maximum output	8V RMS
	Rated output	1V RMS
	Line inputs	180mV (for 1V output)
	Phono input	3mV (1kHz, 1V output)
	Phono overload	150mV (1kHz)
Frequency response	Line inputs	20Hz to 20kHz –0.5dB
		10Hz to 80kHz –3dB
	Phono input	20Hz to 20KHz
		+/–0.5dB
Muting	Turn-on delay	approx 5 seconds
	Turn-off delay	approx 0.004 seconds

done with the volume control ...sitioned between say minimum and 12 o'clock, it may be relevant to recalculate our figures for that range. The original circuit yields a noise figure of about –98dB for the control positioned at 30% of its range (12 o'clock), while the modified circuit returns a theoretical reading of –109dB – still a substantial 11dB improvement in the S/N ratio at this volume setting.

Well, after that barrage of noise figures you could be forgiven for thinking that this design was completed on theory alone – not so. At a very early stage in the development of this project the above figures were confirmed with both objective, and subjective testing. The only real problem that we encountered was that some of the very low noise figures embarrassed our test gear somewhat, and we had to resort to connecting the preamp channels in *series* to bring the resulting noise level above that of the instruments' own noise floor.

As an interesting aside, we briefly contemplated a 'straight through' mode for the preamp, where the signal source is routed directly to the output via the volume control – without passing through any active circuitry. While it seems that this system should provide the highest quality of all, it unfortunately falls foul of the dreaded volume control and its series resistance.

It follows that to maintain the correct input impedance (and load for the signal source) in this case, the combination of the volume pot and the power amp's input impedance has to be around 50k ohms. This in turn means that when the volume control is set to anything less than maximum, the power amp is operating with a relatively high resistance in series with its input.

Now, just as with a high quality op-amp, the power amp's performance will be severely compromised by the above conditions. In short, the basic preamp requirements of a high input and a low output impedance are not satisfied. Needless to say, we dropped *that* idea like a hot potato...

That's about it for the overall features and design. We can now take a look at the actual circuit, which is really quite simple – despite the numerous demands we've placed on its performance.

That's all we have space for in this issue. Next month we'll look at the final circuit and move on to the construction and trouble shooting of the pre-amp plus a few installation hints.

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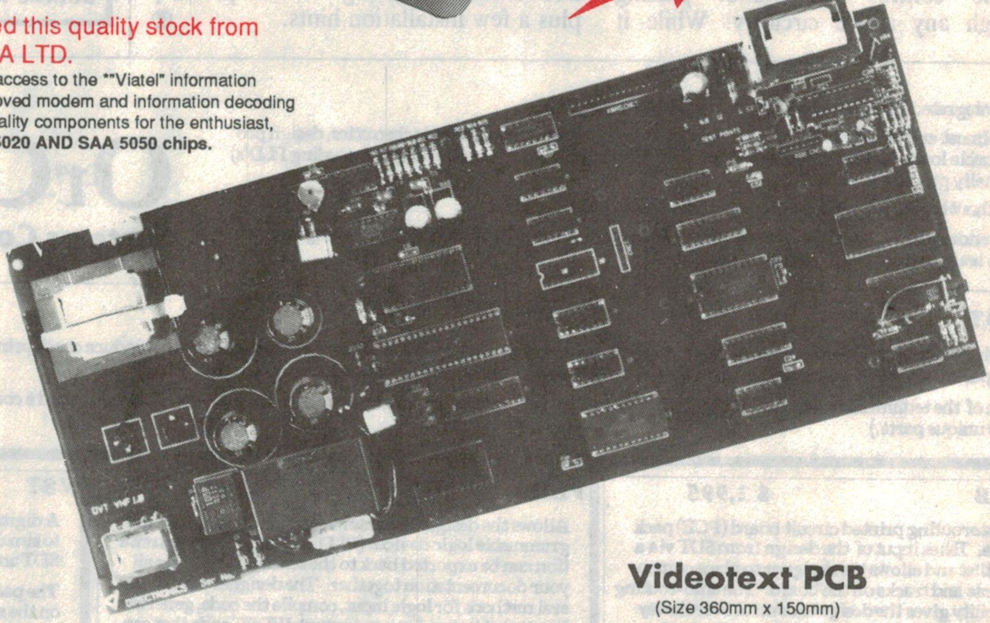

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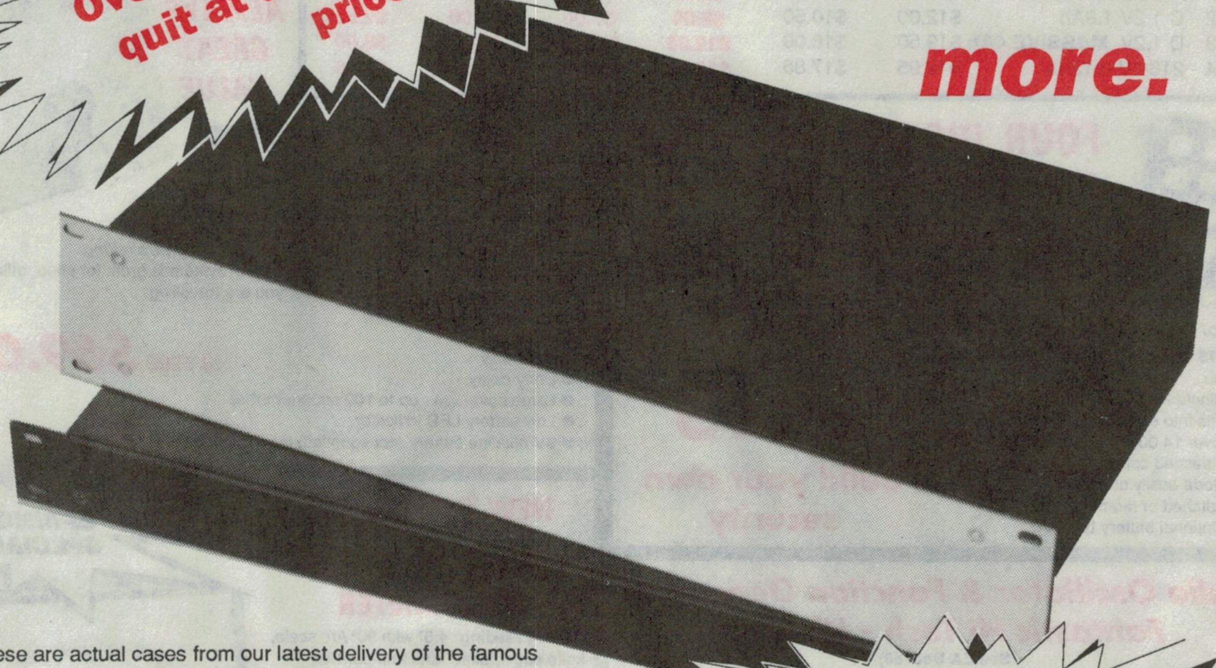

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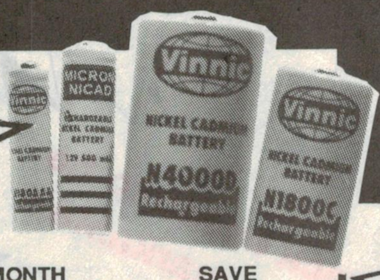

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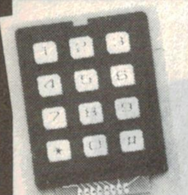

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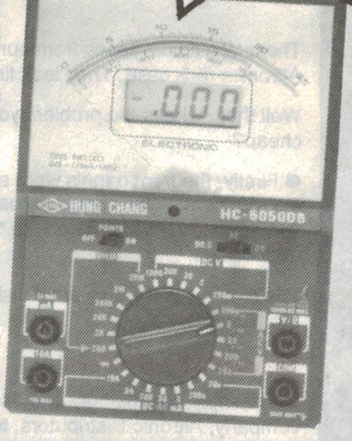

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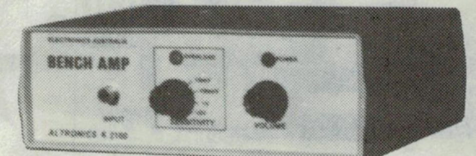

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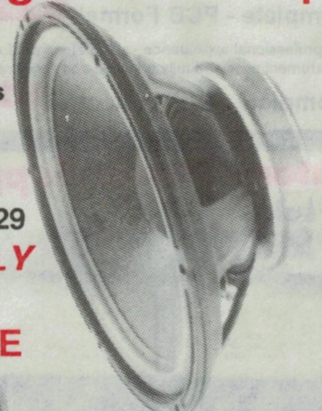

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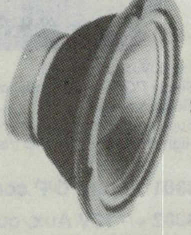

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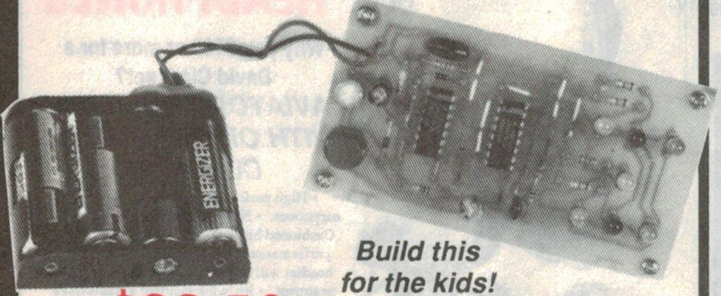

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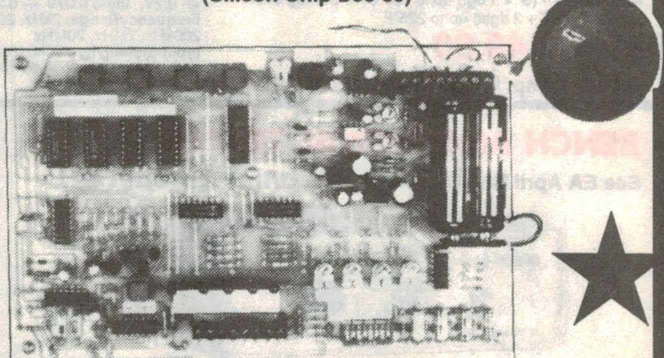

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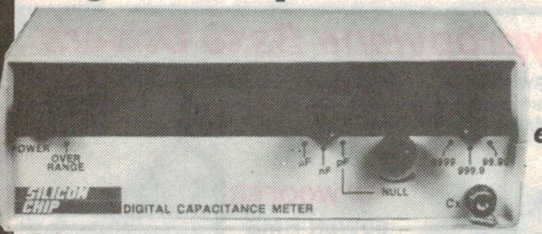

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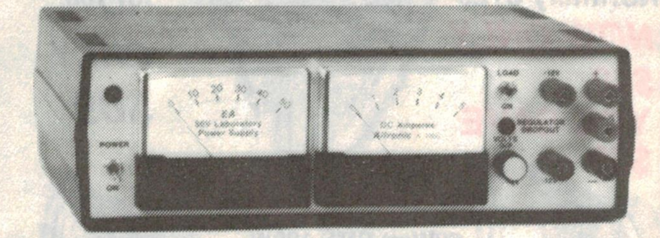

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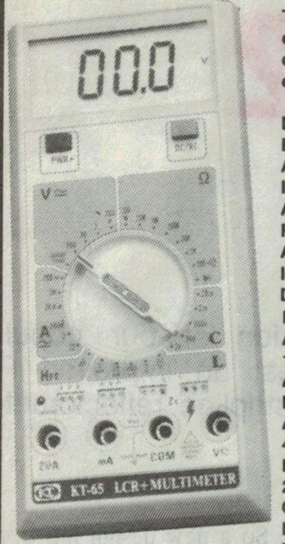

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VHF Powermatch Mk2 - three accessories

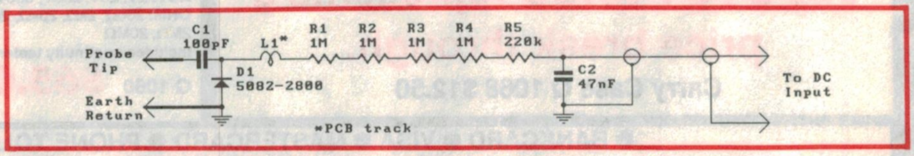
In this second article describing the updated (and upgraded) version of our popular multi-purpose RF test instrument, we look at three useful accessories: an improved RF voltmeter probe, a detector head for power measurements and a microstripline reflectometer head for SWR measurements.

by JIM ROWE

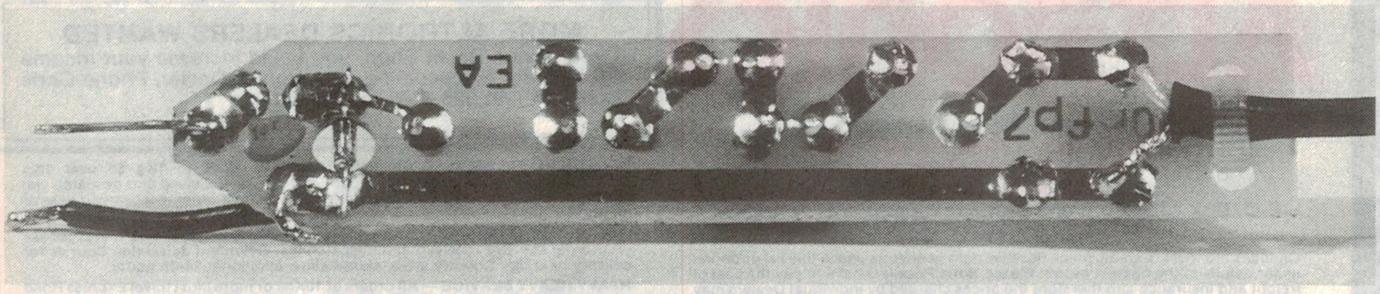
The RF voltmeter probe described as part of the original VHF Powermatch design back in the February 1971 issue was a fairly crude affair, although it did use a Schottky or 'hot carrier' diode and was housed in a rather neat little shielded probe casing which was marketed at that time under the 'Jabel' brand. The circuitry itself used simple point-to-point wiring between eyelets on a small strip of acrylic plastic, and the response was rather 'bumpy' at UHF, even though some care had been taken to reduce lead lengths in the RF section of the circuit.

Unfortunately the probe casing used is no longer available, forcing us to adopt a different approach to the construction of an updated probe. In any case the original value of multiplier resistance used to achieve correct calibration is no longer suitable, due to the higher input resistance of the op-amp metering circuit used in the new VHF Powermatch. So a new design has been indicated, for these reasons at least. Happily this has also allowed the use of a PC board, to lower parasitic impedances in the RF detector loop and help achieve a smoother and more consistent performance.

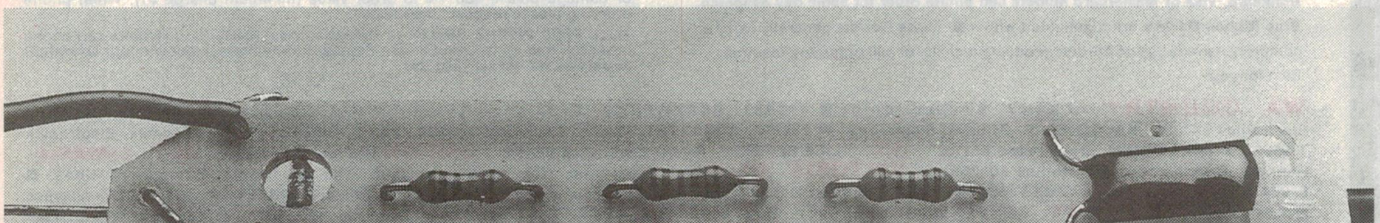
The actual circuit of the probe is still



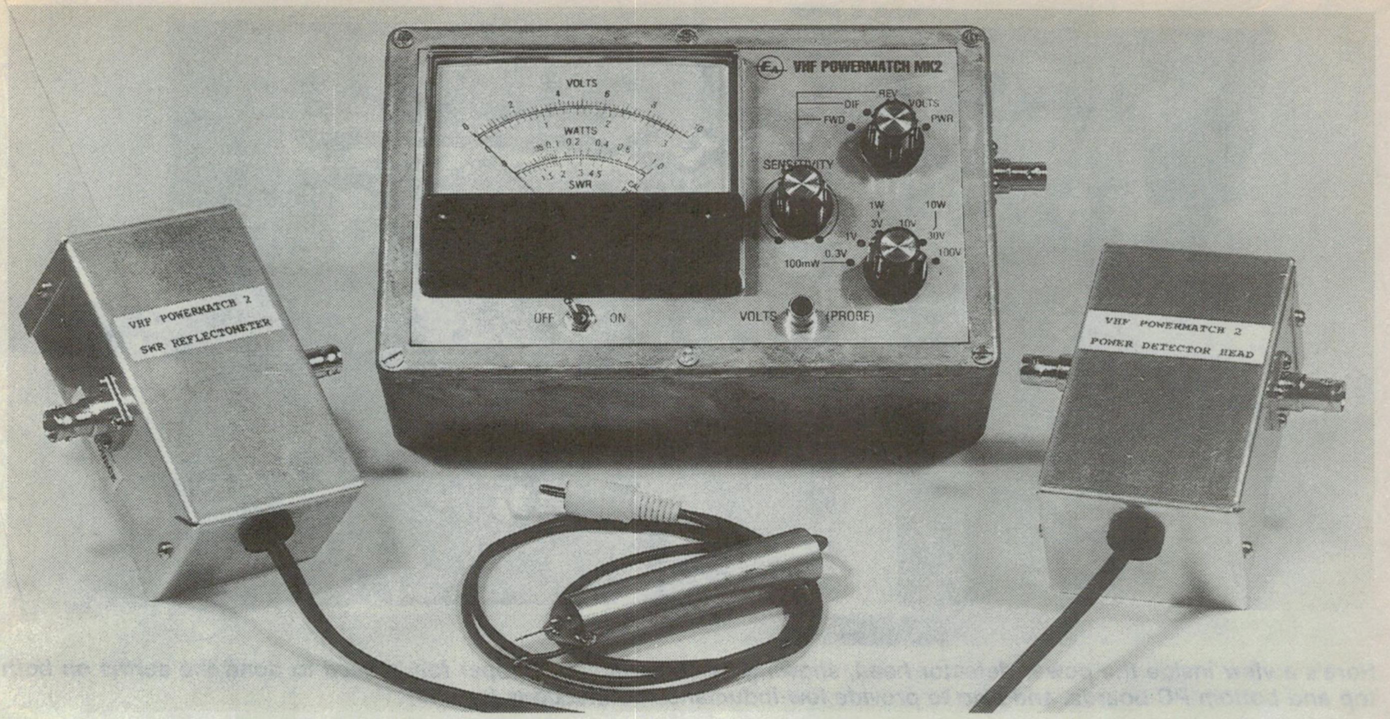
The circuit for the RF probe is quite conventional – a half-wave rectifier using a Schottky diode.



A view of the copper side of the probe PCB. The diode and input capacitor are mounted on this side to minimise lead lengths.



And here's the other side of the board, showing the rest of the components and the diode clearance hole.

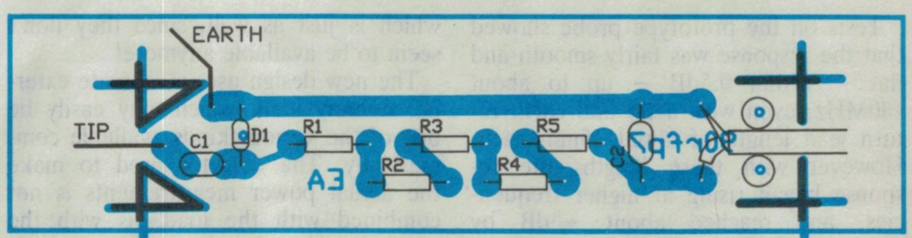


essentially the same as before, with a simple half-wave detector/rectifier followed by an RC filter and calibrating multiplier – see Fig.1. There's nothing particularly special here, as many RF voltmeter probes use the same basic configuration. As before an HP 5082-2800 Schottky diode is used, because of its superior performance extending into the UHF region.

Of course the real trick with this type of probe is not the circuit itself, but the construction. For reasonably smooth performance at UHF, the series parasitic inductance in the RF loop formed by series capacitor C1 and diode D1 must be reduced to the absolute minimum, while at the same time not adding any more stray capacitance than can be avoided.

In practical terms this boils down to reducing the length of the probe tip, the leads of C1 and D1 and the earth return lead all to the absolute minimum, with a layout still designed to allow assembly of the components without undue risk of damage – while at the same time producing a probe that is capable of being used to make useful measurements. Not an easy thing to achieve!

The PCB for the new probe measures only 86 x 15.5mm, and is designed to slip inside an 80mm length of 16mm OD thinwall brass tubing, of the type available from many hobby stores. The two corners of the PCB at the tip end are cut away, to allow the board itself to extend forward and minimise the length of tip needed to contact the circuit under test.



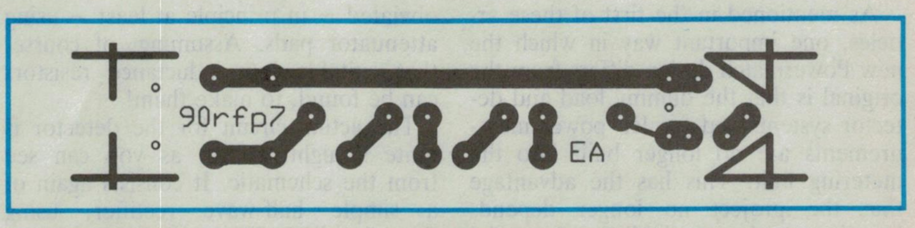
Here is the probe overlay diagram, to assist in wiring it up correctly. The output cable is secured by a nylon cable tie.

The board pattern is also designed to minimise the length of C1-D1 loop, both components being mounted directly on the copper side and with the diode located in a 4mm clearance hole to minimise lead length.

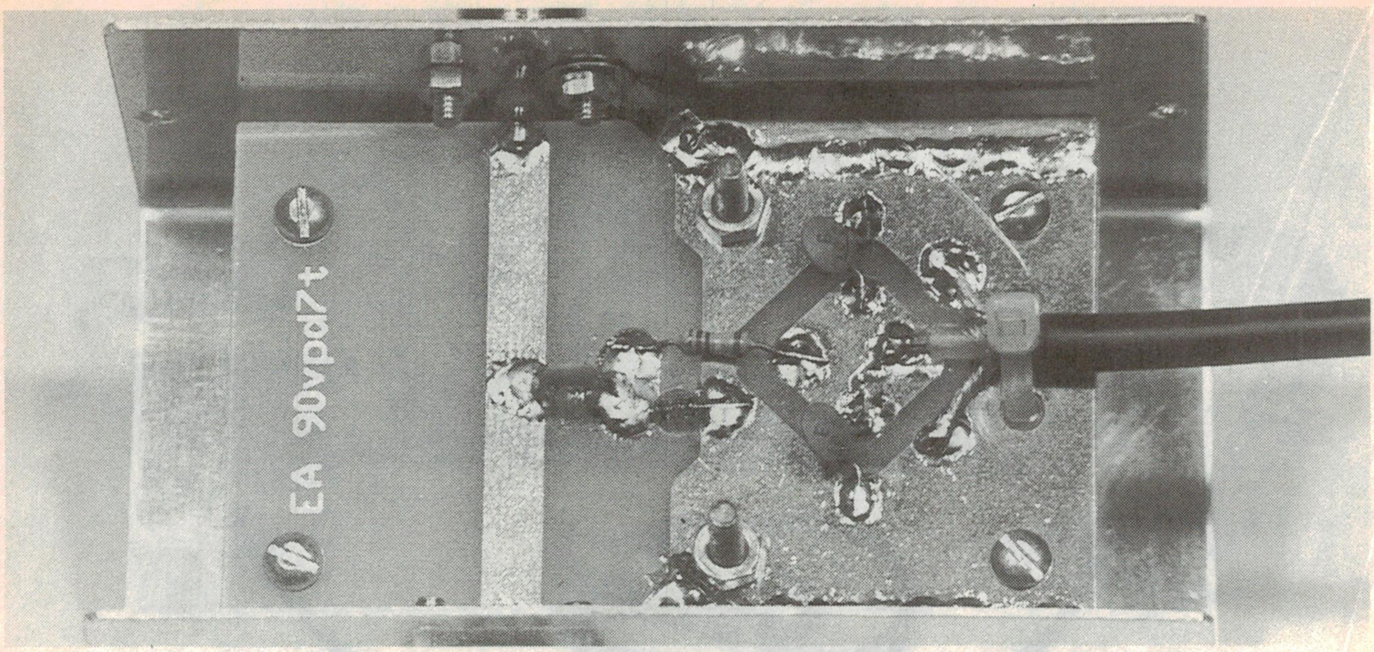
Resistors R1-R5 are the additional multipliers, used to correct for the fact that the rectifier output is essentially equal to the *peak* value of the RF input. A small amount of UHF decoupling between R1 and the RF loop is provided by a narrow PCB track, whose inductance is indicated as L1. Capacitor C2 is an output filter capacitor, and this and the five resistors are all mounted on the normal 'component' side of the PCB, as they carry only DC. The shielded output cable to the Powermatch metering unit is anchored to the rear end of the PCB via a small nylon cable tie, passing through a pair of 3mm holes.

The construction of the probe should be fairly clear from the pictures and the overlay diagram. The main thing to watch is that C1 and D1 should be mounted with the minimum possible lead length, taking care at the same time not to damage them during soldering. You may need to scrape back the leads of C1, carefully removing any ceramic flash so that they can be soldered as close as possible to the body.

Note that the 'earth return' lead from the board connects immediately to the end of the brass shield tube, and then proceeds to the circuit under test.



And here is the probe PCB etching pattern actual size, for those who like to 'roll their own'...



Here's a view inside the power detector head, showing its construction. Copper foil is used to bond the earths on both top and bottom PC boards, and also to provide low-inductance connections for C1.

Tests on the prototype probe showed that the response was fairly smooth and flat – within 0.5dB – up to about 180MHz, even with a tip and earth return lead length of about 15mm each. However with these lengths the response began rising at higher frequencies, and reached about +3dB by around 350MHz. But this rise could be reduced significantly by shortening both tip and earth return lead length; with them each reduced to a couple of millimetres, the response rise was still only +2.5dB at 500MHz.

So tip and lead length now seem to be a primary factor controlling the response of the probe in the UHF region. But providing these are kept to a bare minimum, and their effect understood, the probe seems to be capable of making quite reliable measurements to at least 500MHz.

Note that if you use the PCB pattern shown (90rfp7), and keep the leads of C1 and D1 as short as possible, the performance of your probe should be very close indeed to that of the prototype.

RF power detector

As mentioned in the first of these articles, one important way in which the new Powermatch design differs from the original is that the dummy load and detector system used for RF power measurements are no longer built into the metering unit. This has the advantage that the project no longer depends heavily on the availability of special low-inductance high power resistors – which is just as well, since they don't seem to be available anymore!

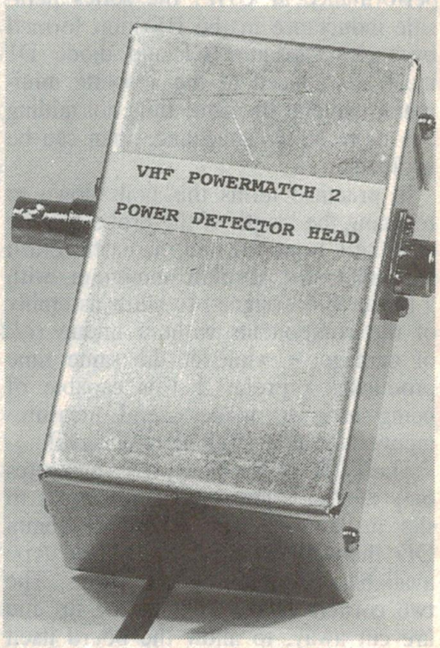
The new design uses a separate external dummy load, which may easily be one of the various kinds available commercially. The detector used to make the actual power measurements is not combined with the load, as with the original design, but is now separate. It is designed to be connected directly into the RF line, as close as possible to the load.

This approach has the advantage of flexibility, allowing the use of different dummy loads for different bands. Providing the antenna is known to be correctly matched, the detector could even be used to monitor output power during normal transmission.

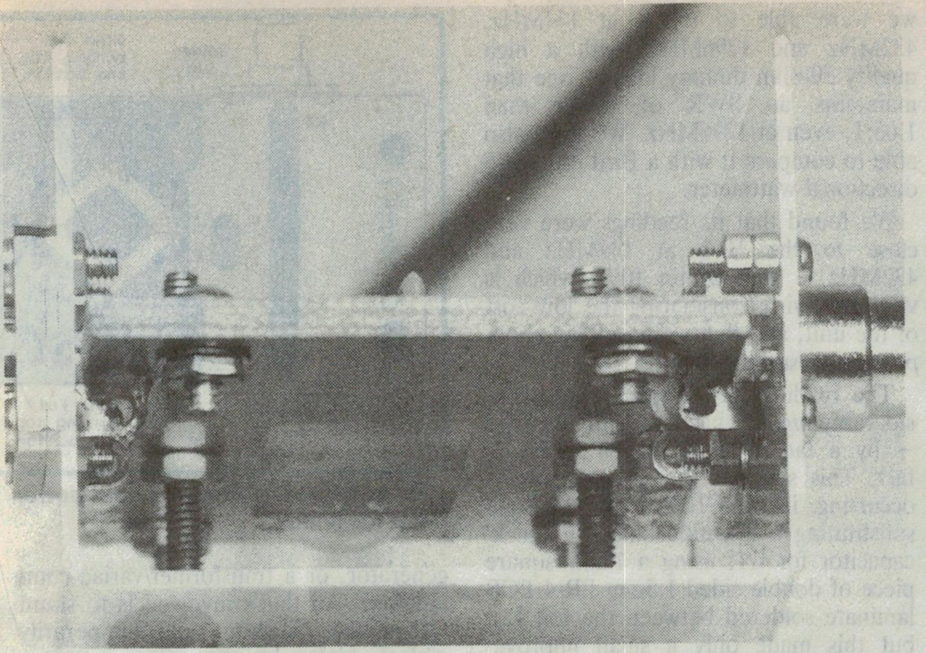
Of course connecting the detector directly into the RF line, as opposed to the original scheme of driving it via a resistive voltage divider across the dummy load, does involve compromises of its own. The most obvious of these is a limitation on the maximum power level, due to the 70V PIV rating for the Schottky-barrier detector diode. This corresponds to an RF power level of 12.25W. However this limitation can be obviated – in principle at least – using attenuator pads. Assuming, of course, that suitable low inductance resistors can be found, to make them!

The actual circuit for the detector is quite straightforward, as you can see from the schematic. It consists again of a simple half-wave rectifier, using Schottky diode D1 in shunt connection and coupled to the RF line via capacitor C1. Resistor R1 conveys the DC output to the metering unit input, with capacitors C2 and C3 combining with R1 to form a low-pass filter.

As noted previously, this kind of rectifier can give an output that is quite accurately proportional to RF power on the line, providing that the line is correctly terminated in its correct load resistance (i.e., a good dummy load), and that the RF signal to be measured is 'clean' – i.e., free from harmonics or other spurious signals. This should cer-



A shot of the assembled in-line RF power head, which fits in a small utility box. Maximum power is 12W.



A view underneath the PCB assembly of the power detector head, showing the way solder lugs are used to bond the underside to the BNC socket earths.

tainly be the case with a correctly adjusted transmitter or transceiver.

Assuming these initial conditions are met, the rectifier's output will be directly proportional to the square root of the RF power level if three basic conditions are satisfied. One is that the diode used is a close approximation of an ideal rectifier, at the frequency concerned – a condition best met at VHF and UHF by using a Shottky or 'hot carrier' diode, as we're using here.

The second condition is that the DC load resistance should be at least 500 times the effective AC source resistance (here 50 ohms) – again easily met here, since we are using an electronic metering circuit with an effective input resistance of over 2M – much higher than 25k.

And the final condition is that the discharge time-constant of the detector's rectifier circuit should be equivalent to at least 100 periods of the lowest frequency to be measured, and preferably much longer; again a relatively easy condition to meet here. In fact with the values chosen, the discharge time-constant is about 40us, which would allow reasonably accurate measurements down to at least 52MHz. (If you wish to go lower, the value of C1 can be increased – but at some sacrifice to UHF performance.)

As with the RF probe, it's the physical layout of the detector that is rather more critical than the actual circuit, in determining its performance. The trick here is to come up with a configuration that will again allow very short lead lengths for the RF loop components C1 and D1, while providing as little disturbance as possible to the RF line.

After trying a number of different approaches, the one finally adopted is as shown. The RF line is passed through a small box in the form of a short (50mm) length of microstripline, connected directly between a pair of BNC connectors. The microstripline is etched on a small PCB board, which is also used to support the detector components – rigidly and in easily reproducible fashion.

Actually the detector uses two PC boards clamped together, with the second board attached firmly under the first via four 3mm screws and nuts. The second board provides the ground plane for the microstripline, and is used to form what is effectively a single PCB 3mm thick – twice the normal thickness.

This trick of using two normal PC boards clamped together to form a double-thickness board was used in the original Powermatch, for the SWR reflectometer. It's also used again in the new reflectometer, to be described shortly. The advantage is that it allows the active conductor of the microstripline to be made rather wider and less critical (for a required impedance of 50 ohms) than would be the case with a single 1.5mm-thick double-sided PCB – but without calling for the use of 3mm-thick laminate, which is much more expensive and harder to obtain.

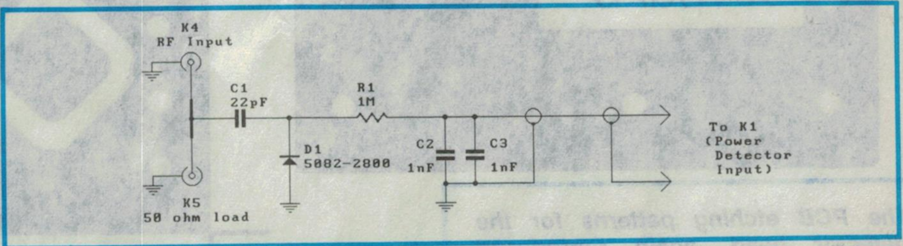
In the case of the power detector the two boards measure 76.5 x 50mm, and are coded 90vpd7t and 90vpd7b. All of the components mount on the upper board (/t), with the lower board (/b) used only for the ground plane.

As before, some care has been taken to minimise the lead length for detector components C1 and D1. Ceramic disc capacitor C1 connects from the centre of the microstrip conductor to the centre of the adjacent pad, with its leads cut to the bare minimum necessary to achieve reliably soldered joints. As this makes them too short to bridge the gap, two pieces of 0.1mm copper foil 4 x 6mm are bent into 'L' shapes, and soldered to the PCB to provide low-inductance lead extensions. The leads of C1 are then soldered to the tops of the L's, as close to the body as possible.

Similarly diode D1 again has its leads cut about 4mm from its glass body, and is suspended in a 4mm-diameter clearance hole to allow the leads to come into contact with the PCB copper pads immediately after emerging from the glass.

As D1 connects to the earthy outer area of the top PCB, rather than to the lower ground-plane PCB, it is most important that the earthy areas of both PCBs be connected together – and to the earthy sides of both RF connectors – as intimately as possible. In other words, with the absolute minimum of series impedance.

This is achieved by bonding the edges of the boards together on three sides, using thin (0.1mm or .004") copper shim, of the type available at hobby stores. The shim is cut into strips 10mm wide, which are bent around the edges of the boards and soldered along their lengths on both sides, as can be seen



And here is the schematic for the detector head. Again it's very straightforward – it's really the construction that is critical.

VHF Powermatch

from the photo's.

To achieve a low impedance connection to the BNC sockets, solder lugs are mounted under the mounting nuts of two screws on each socket. These are then bent so that they are in intimate contact with the copper laminate on both upper and lower boards, when the board assembly is mounted in the box, and soldered in each case. A slightly tricky operation, but it can be done quite readily when you proceed carefully.

Output series resistor R1 and filter capacitors C2/C3 are also mounted on the top of the board, but their leads are rather less critical. Those for R1 are simply 'cranked' to allow the resistor to sit horizontally about 2mm clear of the board, while the leads for C2 and C3 are bent outwards as with C1. Similarly the shielded output cable is soldered to the top of the board, being again clamped in position using a nylon cable tie passing through a pair of 3mm holes through both boards.

As well as being supported by the BNC sockets and solder lugs, the PCB assembly is also supported by a pair of 3mm (1/8" W) x 30mm machine screws with multiple nuts, passing through both boards centrally near the BNC sockets. The nuts are adjusted so that the PCB assembly can be lined up accurately with the BNC sockets and solder lugs.

Hopefully this will all be fairly clear from the photo's and the PCB overlay diagram.

If you follow the construction of the prototype RF detector closely, you should achieve results very similar to those achieved. Thanks to the generous assistance of Dick Norman VK2BDN, we were able to try it at 144MHz, 432MHz and 1296MHz, with a high quality 50-ohm dummy load – one that maintains an SWR of better than 1.05:1, even at 1296MHz. We were also able to compare it with a Bird Model 40 directional wattmeter.

We found that its readings were very close to the Bird at 144MHz and 432MHz – well within 10%, which is very gratifying considering the low cost of the unit, and that we're talking about *power* measurements.

The readings at 1296MHz were considerably *higher* than those of the Bird – by a factor of about 3-4 times, in fact. This suggests that a resonance is occurring, in the C1-D1 loop. We tried substituting a low-inductance 'gimmick' capacitor for C1, using a 10mm-square piece of double sided 1.5mm FR-4 PCB laminate soldered between the foil L's, but this made only a small improvement. Much the same occurred when we tried an SMT chip capacitor for C1 instead, again between the two L's (which were cut shorter).

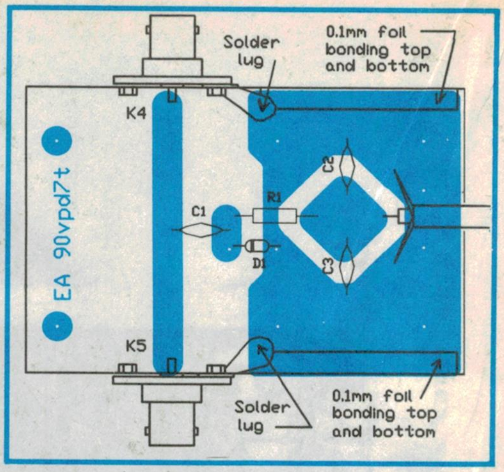
It looks as if the intrinsic inductance of D1 may be the main problem at 1296MHz, and at present I can't see any way around this. But at least you can make quite accurate measurements up to 432MHz, and relative (if optimistic) measurements at 1296MHz...

Incidentally the exact calibration for power measurements will depend at least partly on the value of R1, as well as the resistors associated with SW2A in the metering unit. You may need to trim R12, R14 or R15 to achieve accurate power readings on the three ranges.

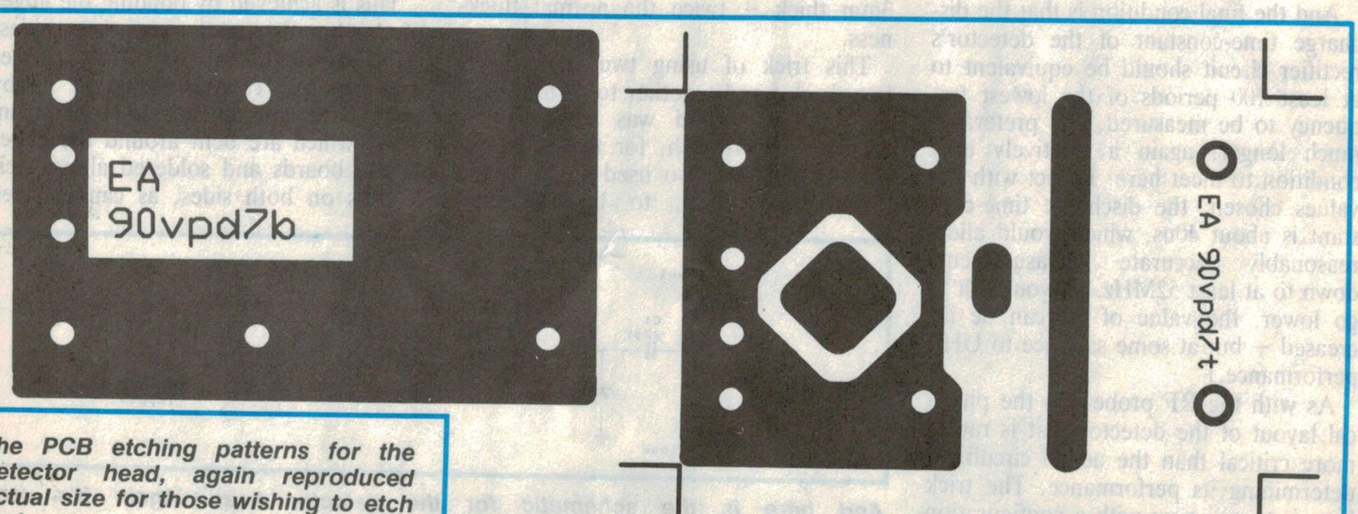
You can actually perform the calibration with a DMM and a source of low-frequency sinewaves – such as an audio generator, or a transformer/variac combination. All that's involved is to shunt C1 in the detector head temporarily with a high-value capacitor – say a 2.2uF or 4.7uF metallised polyester. This will extend the detector's time-constant to around 4-8 seconds, so that the readings should be quite accurate even at 50Hz.

To produce FSD (full-scale deflection) on the 100mW range, you should need 2.236V RMS fed into either of the head's two BNC connectors. This assumes that you have already set the calibrating trimpot VR2 in the metering unit, to give accurate readings on the DC volts ranges. If you don't get FSD on the 100mW range with this input voltage, I suggest that you trim the value of R12 in the metering unit, with a small series resistor or large shunt resistor as appropriate. (Don't touch VR2, as this will upset the DC and AC voltage calibration.)

Similarly the input voltage to produce FSD on the 1W range should be 7.071V



The overlay diagram for the power detector head.



The PCB etching patterns for the detector head, again reproduced actual size for those wishing to etch their own.

RMS, and for the 10W range it should be 31.623V RMS. Ideally they should be checked in this order, and if necessary the values of R14 and R15 trimmed to bring them into line. Then you can remove the temporary capacitor from the detector head, and close it up again.

A final point about this power detector. Because of the 70V peak inverse rating on the 5082-2800 Schottky diode, the absolute maximum power level rating on the detector head is *very definitely* 12.25 watts – and that's for zero AM. If you exceed this level, even very briefly, the diode will almost certainly 'kark it'.

I can testify to this; I've already blown a couple of diodes myself. And at $2.50 a 'pop', it can become expensive as well as irritating...

The junctions of Schottky diodes are really quite fragile, so make sure that the power level applied to the head is always safely below the 12W mark.

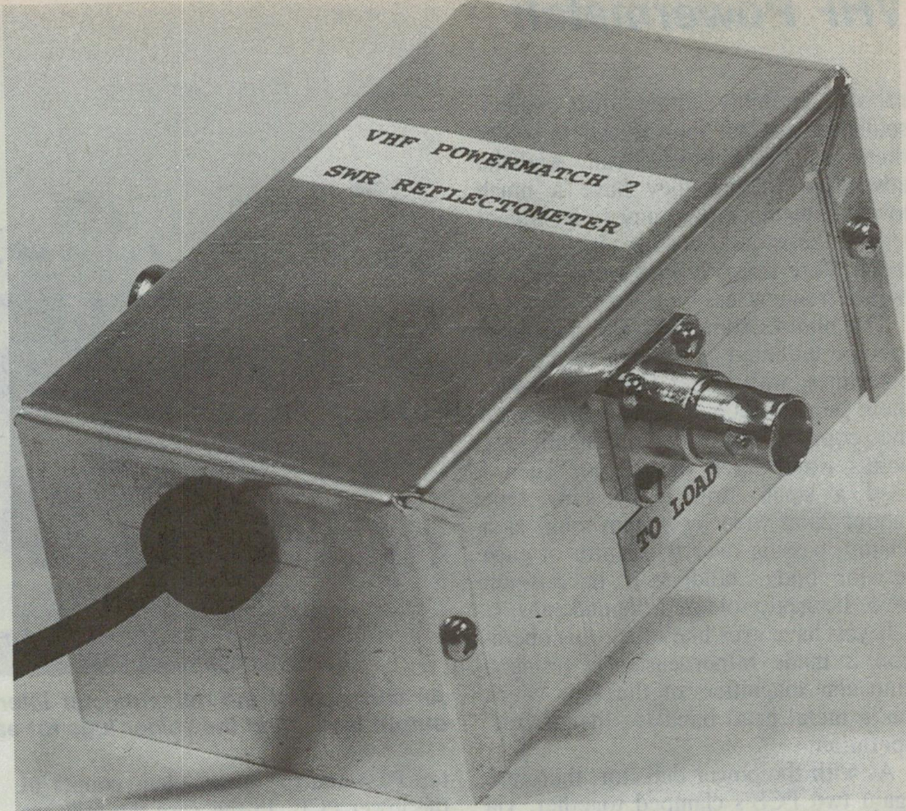
SWR reflectometer

The original VHF Powermatch system included a simple directionally-coupled microstripline reflectometer, to allow measurement of SWR. As noted above it was based on the use of two standard 1.5mm-thick PC boards clamped together to form an effective 3mm-thick composite board.

Independent tests showed that this existing SWR reflectometer design worked quite well up to about 500MHz. However the specific 'Epocor' grade of epoxy-fibreglass laminate material it used is no longer readily available, having been effectively replaced by the 'FR-4' grade. This has a different dielectric constant from the earlier material, so that re-design has been necessary to restore the correct characteristic impedance for the microstriplines.

This being the case, I've also taken the opportunity to make other changes, designed to improve the performance of the reflectometer at UHF.

The basic circuit is exactly the same as before. As you can see from the schematic, it consists of a central straight microstrip line which is inserted in series with the main RF line. Alongside it are two shorter coupled lines, arranged with matching terminations at opposite ends so that one effectively picks up a 'forward power' component, and the other a 'reverse power' component. Simple half-wave detectors at the unmatched ends – again using Schottky diodes – produce DC outputs from each, to feed to the metering circuit for comparison.



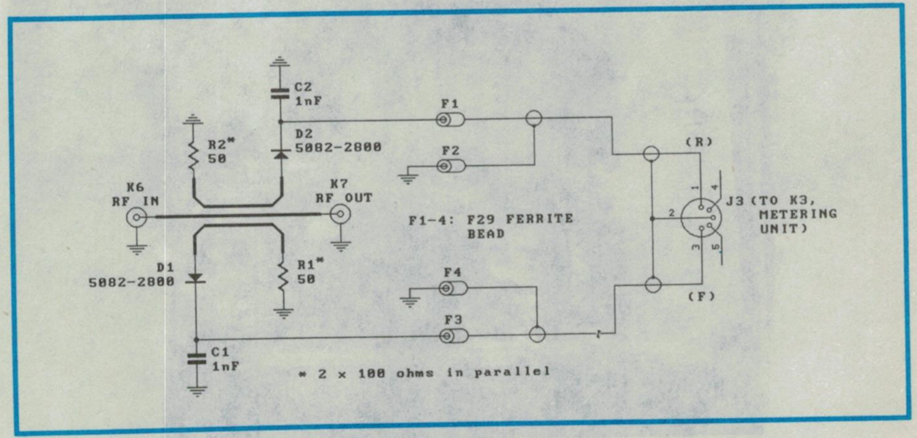
The SWR reflectometer head looks similar to the power detector, but is rather different inside. Again it's in a small utility box.

In the original design, the bypass capacitors at the output of the detectors were of the tubular 'feedthrough' type. While this worked reasonably well, it made it difficult to keep the diode leads really short. This time around I've used standard ceramic disc-type bypass capacitors on the stripline side of the board, with the diodes again suspended in 4mm clearance holes to allow their leads to be reduced to virtually zero. The nett result is again a somewhat shorter and lower impedance detector-loop circuit.

Because of the difficulty in obtaining low-inductance resistors of the normal leaded type, I've also changed the line termination arrangements to use chip-type resistors, as used in surface-mount technology (SMT).

The 100-ohm resistors used (two per termination) are 'Beyschlag' metal film components, type MMA 0204-50-100R (1%). They are rated at 0.25W dissipation and are distributed in Australia by Crusader Electronic Components, of 81 Princes Highway, St Peters NSW, which can supply them in small quantities to normal retailers.

Although these chip resistors are very tiny, measuring only 1.4mm in diameter by 3.6mm long, and are really made for

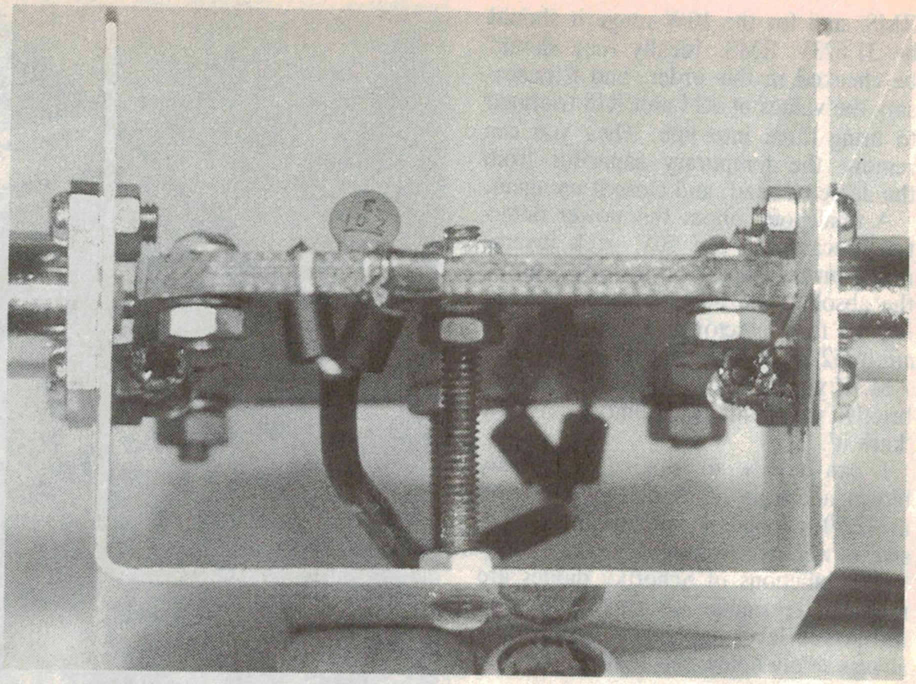


Here's the schematic for the reflectometer, based on coupled microstrip lines. The F29 ferrite beads are important – see text.

robotic assembly rather than manual soldering, it's not too difficult to solder them into this kind of circuit. And the advantage is that they have a much lower inductance than any conventional leaded resistors, making for a very much more effective line termination at higher frequencies.

The photo's show how the chip resistors are mounted at the ends of the coupled lines, with solder fillets. To solder them into position, I first lightly tinned the copper laminate underneath the points where each was to go. Then I used a small strip of masking tape (about 2mm wide by 8-9mm long) as a 'clamp' passing over the centre of each resistor body, holding it in position while I quickly soldered the end caps.

If you have eyes like mine, this operation is made rather easier by using a binocular magnifier, of the type which has a metal head band for 'hands free' operation.



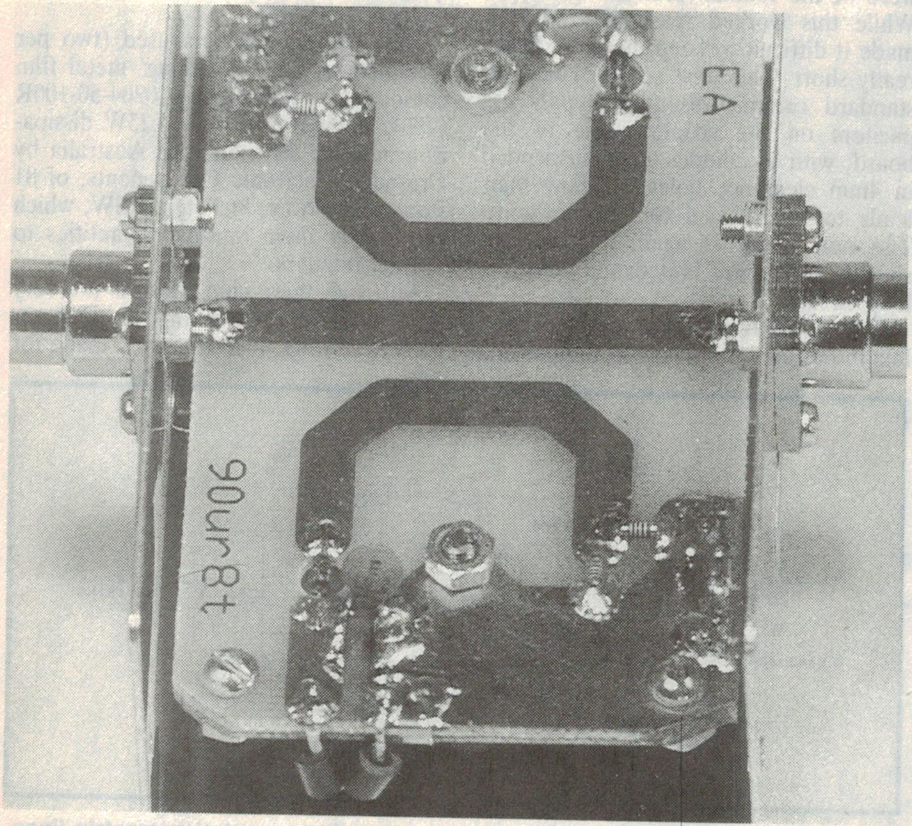
An end view of the reflectometer internals, showing the ferrite beads on the output leads, and the solder lugs for earth bonding.

As with the power detector, there are again two PCB's clamped together, via a 3mm machine screw in each corner. And again, strips of 0.1mm copper foil are used to ensure a low impedance path between the 'earthy' areas on the top PCB and the groundplane copper of the lower PCB. In this case the foils are mainly along the longer side edges, and about 20mm long, with shorter links (about 5mm wide) at the ends, just where the shield braids for the output leads are attached.

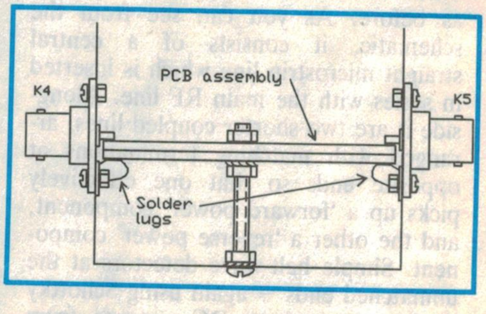
It's again also important to ensure that the groundplane copper of the lower PCB is well bonded to the earthy side of both BNC connectors. As before this is done with a pair of solder lugs for each, only in this case both lugs for each socket are clamped by the screws and nuts underneath the PCB assembly. This makes them a little difficult to see in the photographs.

As you may be able to see, a further pair of 3mm x 30mm machine screws are used to support the PCB assembly in the case. The screws are located near each end of the board, and centrally. Multiple nuts are used on each screw to determine the height of the assembly, so that this can be set for correct alignment with the BNC sockets (see diagram).

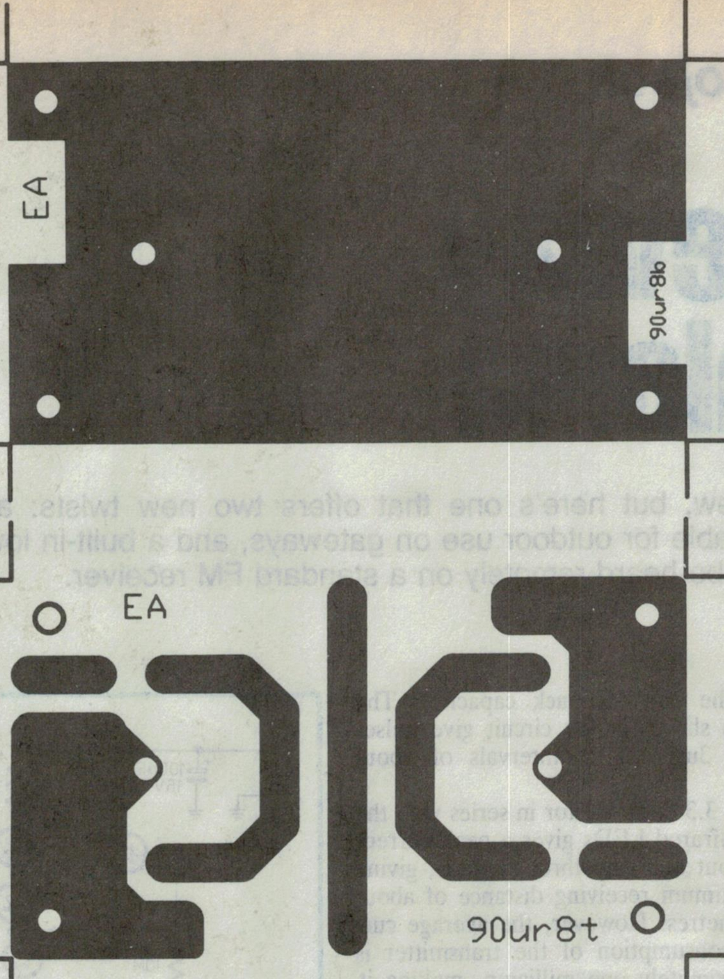
Basically it's the physical construction of this project that is critical, if you want it to perform correctly at VHF and



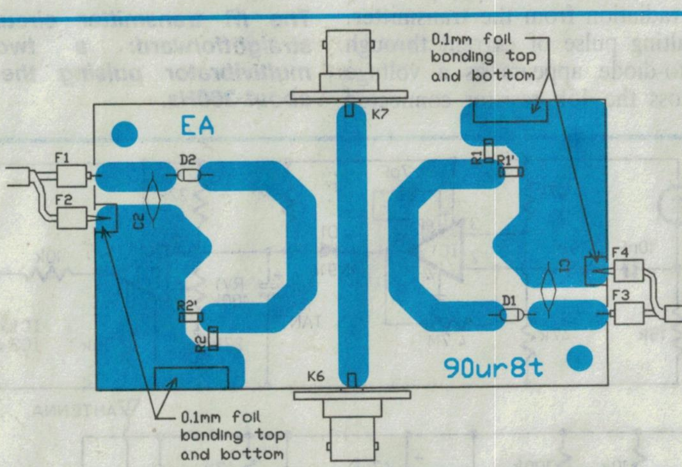
A top view of the reflectometer PCB assembly. Note the chip resistors used to terminate the coupled lines, and the diode relief holes.



Hopefully this diagram will clarify how the PCB assembly mounts in the case, and links with the BNC sockets.



Above: The etching patterns for the reflectometer PCBs, actual size.



And finally, here's the overlay/wiring diagram for the reflectometer. D1 and D2 are suspended in 4mm clearance holes, in the top PCB.

Continued on page 170

NOTE: Suggested additions to metering unit

Following further testing of the VHF Powermatch 2 metering unit described in the July issue, I recommend that you add four 1nF ceramic bypass capacitors to the unit: one across the meter movement terminals, one directly across the rear of the 'Power' input socket K1, and the other two across the rear of the SWR input socket K3, from pins 1 and 3 to the grounded pin 2. These additional bypasses are to further protect the unit against the disrupting effects of RF finding its way into the case.

RF Probe

1 PC board, 90rfp7
1 80mm length 16mm OD brass tube
1 5082-2800 Schottky diode
1 100pF disc ceramic capacitor
1 47nF metallised polyester capacitor
4 1M 1/4W 1% metal film resistors
1 220k 1/4W 1% metal film resistor
Length of shielded cable with RCA plug, nylon cable tie.

Power Detector

1 Pair PC boards, 76 x 50mm, coded 90vpd7t and 90vpd7b
1 Aluminium utility box, 100 x 58 x 45mm
2 BNC sockets, panel mounting flange type
1 5082-2800 Schottky diode
1 22pF disc ceramic capacitor
2 1nF disc ceramic capacitors
1 1M 1/4W 1% metal film resistor
Length of shielded cable with BNC plug, nylon cable clamp, 8 x 2.5mm x 6mm machine screws and nuts, 4 x solder lugs, small piece of 0.1mm copper foil, 4 x 3mm x 6mm machine screws and nuts, 2 x 3mm x 30mm machine screws with 3 nuts and 2 star washers for each.

SWR Reflectometer

1 Pair PC boards, 88 x 50mm, coded 90ur8t and 90ur8b
1 Aluminium utility box, 100 x 58 x 45mm
2 BNC sockets, panel mounting flange type
2 5082-2800 Schottky diodes
4 100-ohm 1% chip resistors, Beyschlag type MMA0204-50-100R (see text)
2 1nF disc ceramic capacitors
4 F29 ferrite beads, 5mm long x 4mm dia with 2mm hole (Neosid type 35-033-35)
2m length of twin shielded wire, 5-pin DIN plug, 6mm rubber grommet, small piece of 0.1mm copper foil, 8 x 2.5mm x 6mm machine screws and nuts, 4 x solder lugs, 4 x 3mm x 6mm machine screws and nuts, 2 x 3mm x 30mm machine screws with 3 nuts and 2 star washers for each.

IR-FM gateway monitor alarm

Doorway monitor alarms are not new, but here's one that offers two new twists: a pulsed infrared light beam that makes it suitable for outdoor use on gateways, and a built-in low power FM transmitter so that the alarm can be heard remotely on a standard FM receiver.

by TIM GREGORY

The project described here was designed to monitor a gateway at the entrance to a plant nursery, the gate being about 25 metres from the customer service area and storeroom. Whilst the nursery isn't very large, it is usually tended by one person who has more to do than just serve customers.

Often in the past, tending other tasks has left the counter and front display area of the nursery unattended, therefore the staff member on duty did not know if someone had entered and perhaps required assistance. What was required was an 'electronic eye' to monitor people entering the display area, and alert the owner. The possibility of theft would also be reduced.

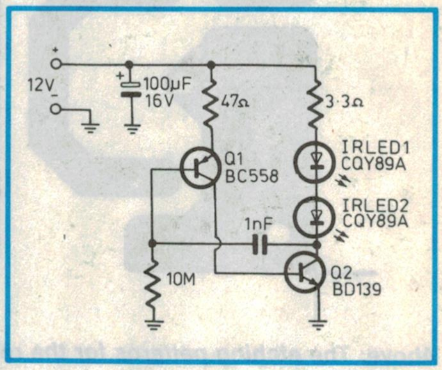
The 'electronic eye' consists of an infrared beam sent across the gateway from a transmitter which is (when there are no obstructions) picked up by a receiver on the other side. When someone passes through the gateway, breaking the beam, the receiver operates a tone generator which is coupled to a low-power FM transmitter. An ordinary FM receiver, tuned to the transmitter at the gate, demodulates the tone and alerts the nursery attendant. The FM receiver may be set in a convenient position in the service area, or consist of a pocket FM receiver situated on the attendant's person.

Circuit details

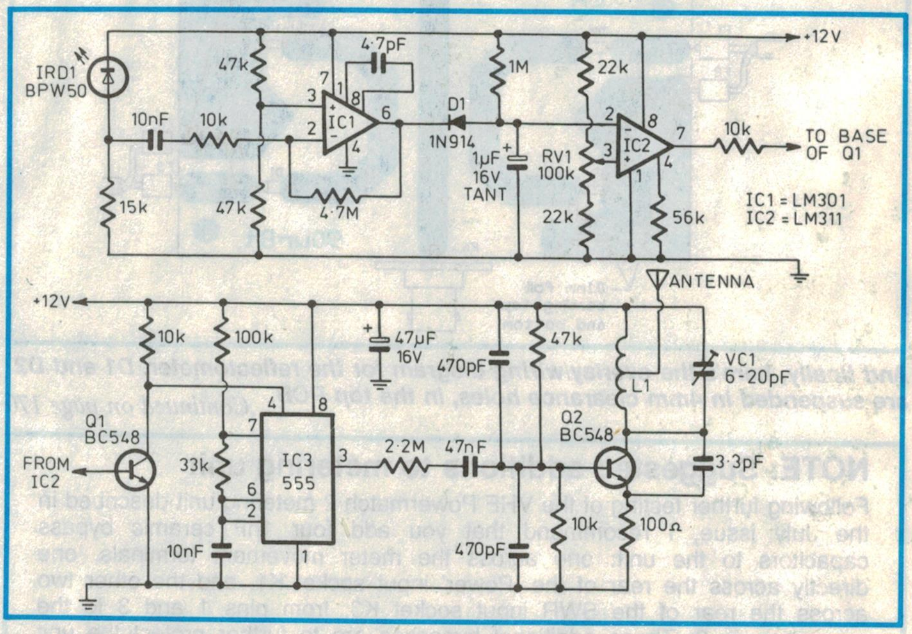
The infrared transmitter consists of a serial multivibrator which allows frequent short intense pulses of current through two infrared LEDs, so that they emit pulses of IR radiation towards the receiver. The frequency of the pulses depends on the supply voltage, the 100uF capacitor across the supply, and the 1nF feedback capacitor. The values shown in the circuit give pulses about 3us long at intervals of about 3ms.

The 3.3 ohm resistor in series with the two infrared LEDs gives a peak current of about one amp through them, giving a maximum receiving distance of about two metres. However, the average current consumption of the transmitter is approximately one milliamp, making it ideal for battery powered operation.

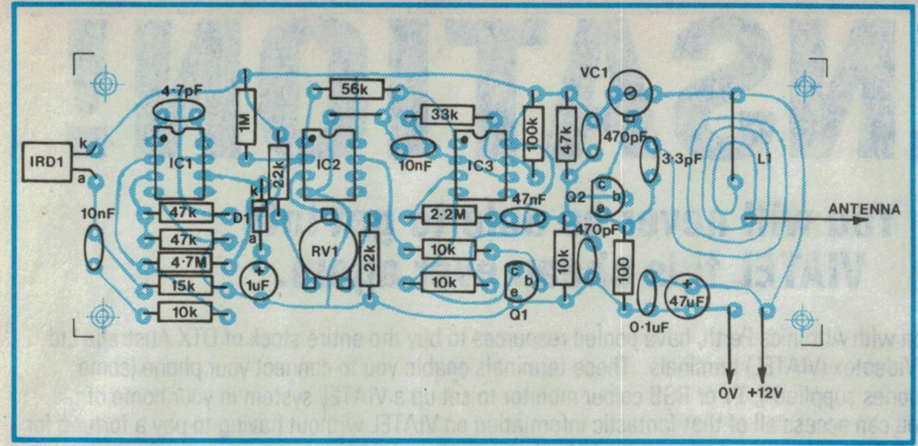
An infrared photo-diode at the receiver conducts when it detects pulses of infrared radiation from the transmitter. The resulting pulse of current through the photo-diode appears as a voltage drop across the 15k resistor connected



The IR transmitter circuit is very straightforward: a two-transistor multivibrator pulsing the LEDs at about 300Hz.



And here's the IR receiver/FM transmitter combination. The receiver IR signal is processed and used to gate IC3, which modulates Q2.



Above: The overlay diagram for the receiver PCB, showing the location of all parts. Note that the RF oscillator's tank inductor L1 is a spiral track on the board itself, with the antenna connecting to a 'tap'.

to the anode, and is connected to the inverting input of op-amp IC1 via a series 10nF capacitor and 10k resistor.

The non-inverting input of IC1 is biased to half the supply voltage by the two 47k resistors and the gain of the op-amp is set to about 500 by the 4.7M feedback resistor. Since the input pulses are applied to the inverting input of IC1, the amplified output pulses are negative-going, and serve to keep the 1uF capacitor at the inverting input of voltage comparator IC2 discharged, via diode D1.

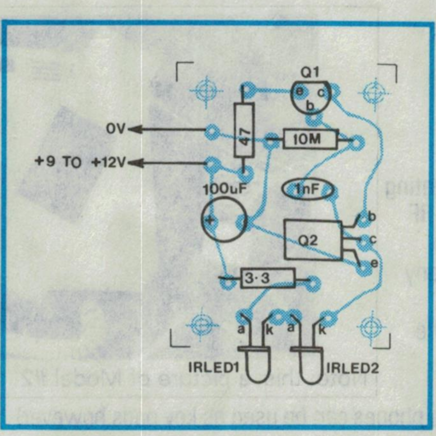
If the infrared pulses are interrupted, IC1 ceases to deliver the negative-going pulses, so the 1uF capacitor is allowed to charge, raising the voltage at the inverting input of IC2.

Pin 3, the non-inverting input of comparator IC2 is held at a constant voltage as set by RV1. When infrared pulses are being received, RV1 is adjusted so that the voltage at pin 3 of IC2 is slightly higher than that of pin 2, giving a high output at pin 7. When the beam is interrupted the voltage at pin 2 rises above pin 3 and so pin 7 goes low.

IC3, a 555 timer, is wired as an astable with the output at pin 3 oscillating at a frequency of about 870Hz – but only when pin 4, the reset input, is high. This input is controlled by IC2 via transistor Q1.

Normally the output of IC2 is high, turning Q1 on via the 10k base resistor

Continued on page 171



The PCB overlay for the IR transmitter, with fewer parts to be placed. Needless to say, the LEDs should face the receiver.

PARTS LIST

IR Transmitter

Semiconductors

1 BC558 transistor (Q1)
1 BD139 transistor (Q2)
2 CQY89A IR LEDs

Capacitors

1 0.001uF greencap
1 100uf 16V electrolytic

Resistors

1 47 ohms 1/4W 5%
1 10M 1/4W 5%
1 3.3 ohms 1/2W 5%

IR Receiver/FM Transmitter

Semiconductors

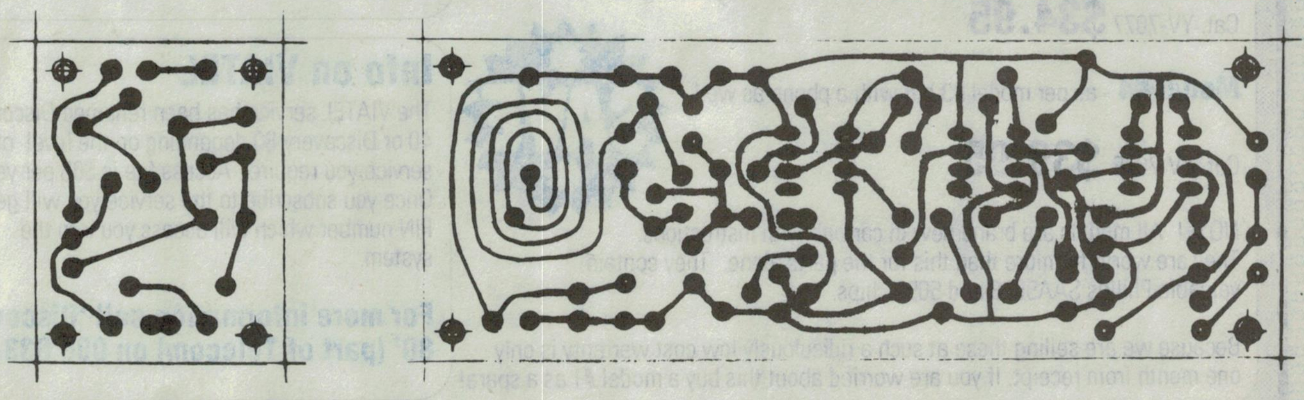
1 LM301 op-amp (IC1)
1 LM311 comparator (IC2)
1 555 timer (IC3)
2 BC548 transistors (Q1, Q2)
1 BPW50 IR diode (IRDI)
1 IN914 or IN4148 diode (D1)

Capacitors

2 10nF greencaps
1 47nF greencaps
1 0.1uF greencap
1 3.3pF ceramic
1 4.7pF ceramic
2 470pF ceramic
1 470uF electroyltic 16V
1 1uF/16V tantalum
1 6-20pF variable capacitor (VC1)

Resistors

All 1/4W 5%:
1 100 ohms
4 10k
1 15k
2 22k
1 33k
3 47k
1 56k
1 100k
1 1M
1 2.2M
1 4.7M
1 100k mini horizontal trimpot



Here are the etching patterns for the two PC boards, reproduced actual size.

VIATEL SENSATION!

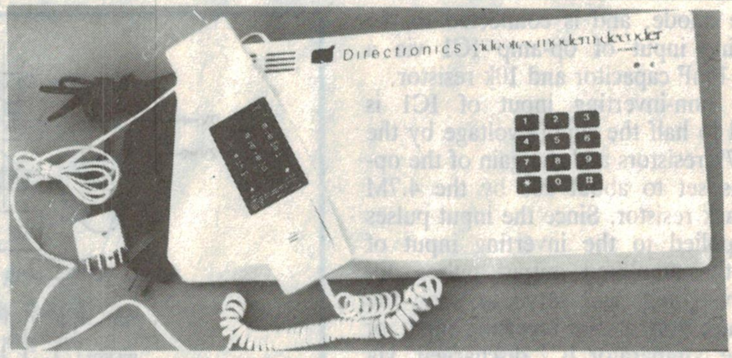
You will never be able to get into VIATEL this cheap ever again.

Jaycar, in conjunction with Altronics Perth, have pooled resources to buy the entire stock of DTX Australia Ltd 'Directronics' brand Videotex (VIATEL) terminals. These terminals enable you to connect your phone (some models even have phones supplied!), TV or RGB colour monitor to set up a VIATEL system in your home of office! Just think, you can access all of that fantastic information on VIATEL without having to pay a fortune for an expensive terminal. You will still need to pay the VIATEL service fee of course!!

Each videotex terminal contains a fully Telecom approved modem and all electronics to decode VIATEL signals and display them on your TV or RGB monitor. We have roughly the same quantities of 4 fairly similar models.

Model #1

(the cheapest) - features full console, numeric keypad (for entering into and operating the Videotex system), RF out (to your TV) but no phone. You can plug any phone into the socket provided of course, The phone is only used to access the Videotex number anyway (some phones can be used as key pads however). This machine is all you really need.



Note: this a picture of Model #2

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Model #2 - identical to above but with a dedicated phone which can be used as a keypad.

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Model #3 - as per model #1 but with RF and RGB video output (for better quality colour on a suitable RGB colour monitor).

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Model #4 - as per model #3 but with a phone as well.

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Because we are selling these at such a ridiculously low cost warranty is only one month from receipt. If you are worried about this buy a model #1 as a spare!

Customers have been disappointed before when we have run out. Make sure you get in quick so that you won't be disappointed. Quantities are strictly limited but once sold, they are gone forever!

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Info on VIATEL

The VIATEL service has been renamed Discovery 40 or Discovery 80 depending on the level of service you require. Access fee is $65 per year. Once you subscribe to the service you will get a PIN number which will access you into the system.

For more information call 'Discovery 80' (part of Telecom) on 008 033 344

NEW BOOKS FOR 1990

Everyday Electronics Data Book

by Mike Tooley

This book is an invaluable source of information of everyday relevance in the world of electronics. It contains not only sections which deal with the essential theory of electronic circuits, but it also deals with a wide range of practical electronic applications.

It is ideal for the hobbyist, student, technician and engineer. The information is presented in the form of a basic electronic recipe book with numerous examples showing how theory can be put into practice using a range of commonly available 'industry standard' components and devices.

A must for everyone involved in electronics.

250 pages 140 x 215mm

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Electronic Power Supply Handbook

By Ian Sinclair

This book covers the often neglected topic of electronics power supplies. All types of supplies that are used for electronics purposes are covered in detail, starting with cells and batteries and extending by way of rectified supplies and linear stabilisers to modern switch-mode systems. IC switch-mode regulators, DC-DC converters and inverters.

The devices, their operating principles and typical circuits are all dealt with in detail. The action of rectifiers and the reservoir capacitation is emphasised, and the subject of stabilisation is covered. The book includes some useful formulae for assessing the likely hum level of a conventional rectifier reservoir supply.

Covers many types of supplies - batteries, simple AC supplies, switch-mode supplies and inverters.

Includes stabilisation and regulators.

Explains operating principles and gives typical circuits.

For technicians, students and enthusiasts.

136 pages, size 135(W) x 2159H)mm

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By David Mellow

The book describes the setting up of an 8 to 16 track studio with an outline of the musical and recording gear needed, but concentrating on the techniques of putting that equipment together into an efficient and productive home studio.

It contains invaluable and hard to come by advice on patchbay wiring schemes and describes how to custom build a rack to suit your own particular requirements.

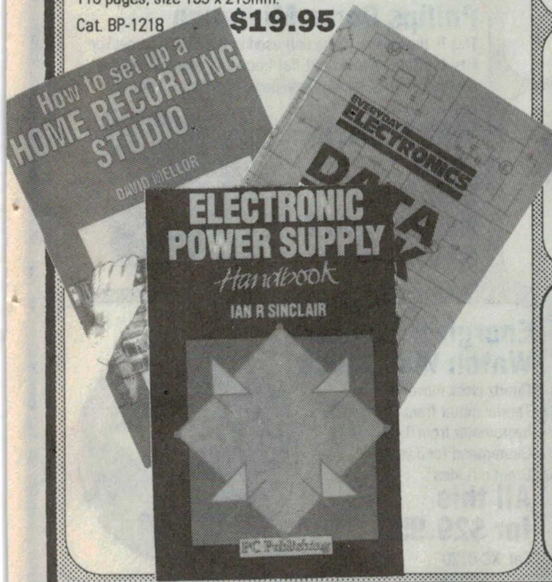
For musicians, recording enthusiasts and students.

Practical details on equipment, wiring, acoustics and sound proofing.

Glossary of terms and lists of useful addresses.

116 pages, size 135 x 215mm.

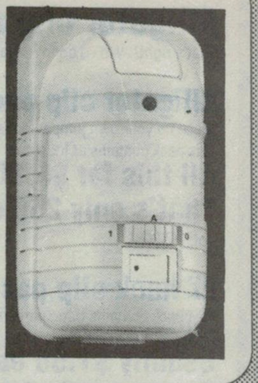
Cat. BP-1218 **$19.95**



Thromatic Security Sensor

NEW

DIRECT IMPORT



This great product utilises a passive infra red detector which controls 240V lights to illuminate at night when a person comes within range. A typical example would be on a verandah. Simply replace the old light switch (outside one) with the Thromatic.

When someone walks within range (up to 15mt away) the verandah is lit up for them for a period of 5 seconds to 10 minutes, or more.

Features: • Fully automatic compact design • Security - keep intruders away • On/Off/Auto master switch on unit • Safety - no more groping in the dark

Suitable for entrances, porches, patios, stairways, garages, basements, hallways, closets, attics, storerooms, warehouses, workshops etc.

Up until now this type of product has been around $100 or more. Jaycar has now directly sourced this product, which effectively cuts out the middle man saving you money.

ONLY $69.50 SAVE $30 over previous models

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Fax-Phone Modem Line Protector

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- ***Uses no power***
- ***Install in minutes***

MADE IN AUSTRALIA

We are all becoming aware that lightning in storms and voltage spikes can severely damage sensitive electronic equipment that is connected to a phone line, i.e.. fax machines, answering machines, modems, etc.

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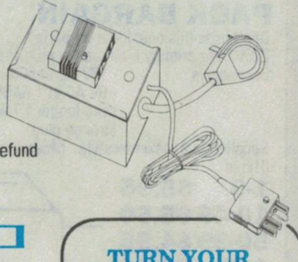

We cannot guarantee that this filter will solve 100% of lightning induced telephone line spikes destroying your equipment. We can say however, that this device will give your equipment a reasonable chance of survival in a storm.

We are offering you a one month trial on this product. If you are not satisfied with its performance return it in original condition along with your receipt for a full refund less post and packing.

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Revolutionises panel and sheet cutting. Ideal for making square/rectangular holes in plastic panels and boxes for switches, LED displays etc.

Panel cutter is ideal for: • Plastic panels and sheets • Building materials made of urethane, polyethylene, nylon, vinyl-chloride, Plywood, rubber sheets, leather, mat boards etc Soft thin metallic sheets made of aluminium, lead, silver etc.

This is a quality tool make in Japan, which will last for years. Replacement blades will be available. Actual tool length 120mm. Supplied with three blades 1 x 5mm and 2 x 10mm diameter.

Cat. TH-1940

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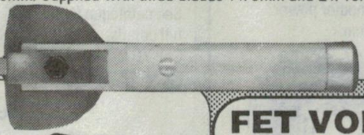

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At last, Jaycar now stocks an 80mm square 12V DC fan. Quality Japanese brushless style. Limited quantities.

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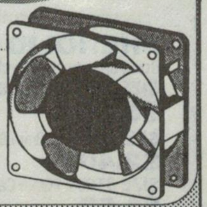

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Features

- Full electronic operation (FET)
- 12A DC & AC current ranges
- High input impedance
- Polarity reverse witch
- Safety test leads
- Zero ohms adjust
- Mirrored meter dial
- Tilt stand
- Fuse protected
- Working indicator

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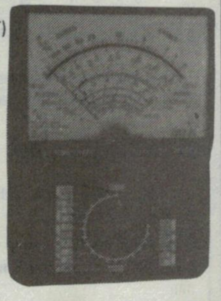

VARTA BATTERY MADNESS

VARTA 2.4 V 100mA/H Ni-CAD

These batteries are encased in a black plastic housing which measures 30 (L) x 16 (W) x 19 (H) mm. They were removed from printed circuit boards by simply cutting of the PC terminals so to use you would need to break open the plastic case. Inside are two 1.2 V cells. So purchase 4 of these, remove 1 cell and you have an 8.2 V (9V 216 type) battery for only $4, not about $20.

Ideal for Hobbyists, experimenters, etc.

To buy these today they would cost about $13 ea.

ONLY $1 each

10+ .90¢ each

100+ .75¢ each

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Alligator clip and EZ hook pack bargains

That's right! We've done it again! With yet another scoop purchase. Alligator clips and EZ hooks in various colours and sizes. To pass the savings on to you we have made packs of them:

Alligator clip pack

Make up your own jumper leads!
This pack contains at least two of each colour with various sizes. Colours are Red, Black, Blue, Green, Yellow and White. Pack of 20.

All this for $5.00
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THIS MONTH'S SPECIAL

EZ hook clip pack

This pack contains three various sizes (40mm, 57mm, 90mm) and different colours. Colours are Green, Yellow, Blue and White. Pack of 20.

Usually $1.50 each
Crazy at only $7.95 pk.

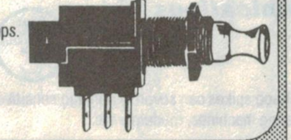
Cat. HP-3030

UNDER 40¢ EACH

12 Volt Push On - Pull Off

Swann brand. Orange knob which you push in for on, and pull out for off.
Rated at 12 volt 16 amps.
Ct. SP-0762

Was $2.95
10 for $15



TWEETER SPECIAL PHILIPS DOME

Philips best. Exposed textile dome for superior transient response and incredibly wide dispersion.
See page 14 catalogue for full specs.
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WAS $26.50
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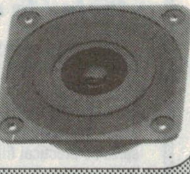
SAVE $6.55



TRANSFORMER MADNESS!!

This transformer has two separate windings 15/0/15 & 0-3 at 5VA.

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or 10 for $15
Don't pay
$9.95 ea

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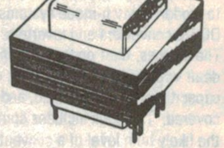

EXPERIMENTORS PLUG PACK BARGAIN

Don't miss this one. Ideal for parts
220V 50hz primary I- no lead or plug supplied
Secondarys - 16V AC at 800mA
- 9V AC at 1.5AMP
Lead length 1.7mt long terminated in a strange plug
Supplied in a maxi box style. Measures 75 (W) x 85 (L) x 60 (H)mm

1-9 $5.95
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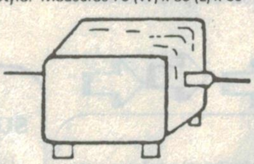
100 + $4.50

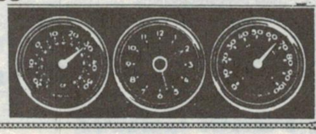
Cat No. MA 2618



RECTANGULAR WALL CLOCK WITH TEMPERATURE AND HUMIDITY

Nautical style. Can be desk or wall mounted. Measures 240(W) x 28(H) x 91(D)mm. Requires 1 x AA batt (not supplied)
Cat. XC-0122

NOW $19.95
SAVE $5



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Contains approximately 3kg of assorted electronic goodies - 'JUNK' if you like, but all brand new components etc. Ideal to fill up your junk box.
Unfortunately due to the massive weight P&P is normal rates plus $5
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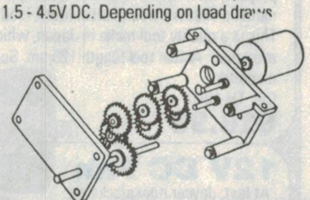
$14.95

SAVE

MOTOR/GEARBOX KIT

Contains motor, brass cog, gearbox housing and all other parts to make various combinations of motor from 2rpm to 1150. Works from 1.5 - 4.5V DC. Depending on load draws from 200-800mA.
See catalogue for full details.
Cat. YG-2712

$18.95



TV Rabbit Ears Antenna

Below 1/2 Price

Two telescopic antenna mounted in a sturdy cabinet which sits on your TV set. Telescopic rods are adjustable for maximum efficiency.
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Normally $19.95
NOW ONLY $9.95

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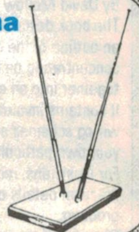
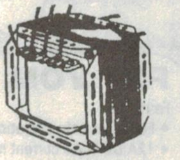


Ferguson Transformer Bargains

PF-4725

A large transformer ideally suited to computer power supplies. Size 115 (L) x 10 (W) x 86 (H) mm.
Primary
2 x 120 V 50hz (240 V)
1 x 110 V
Secondary
16 V Regulated to +12V DC 5A
16 V Regulated to -12 V DC 5A
9.3V Regulated to 5 V DC 5.7A



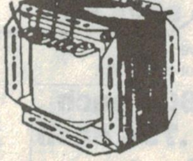
These transformers would normally cost about $80 each. We have a limited quantity available for only $30 each.

A bargain at $30 each

Cat. MM-2040
Due to huge weight mail order customers add $8 extra to normal P & P charges.

PF-4766

A medium size transformer measuring 96 (L) x 96 (W) x 80 (H) mm.
Primary
2 x 120 V 50hz (240 V) • 1 x 110 V • Secondary 10.5V 3A
16V 3A



Normally $70 ea
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PHENOLIC PC BOARD

Stock up now. Well under 1/2 normal price.
SIZE 1 505 x 205mm Cat. HP-9522
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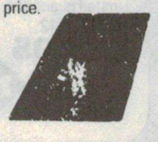
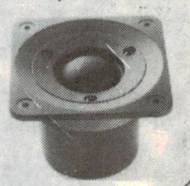
SIZE 2 400 x 170mm Cat. HP-9523
$2.40
SIZE 3 500 x 90mm Cat. HP-9524
$1.60



Philips Dome Midrange

This is the superb dome unit used in the ETI4000 speaker kits. It offers an excellent flat frequency response and it sounds great. See catalogue page 16 for specifications.
Cat. CM-2088

THIS MONTH ONLY
$59.95
Normally $72.50
SAVE $12.55



5mm 3000 MCD LED

An amazing 3000 MCD of brightness in a LED! Lights up red, clear to look at.

ONLY
$3.95 10+
$3.65 Cat. ZD-1796

BARGAIN LED PACK

100 assorted LED's 5mm, 3mm, rectangular plus others.
Normal value about $35
Cat. ZD-1696

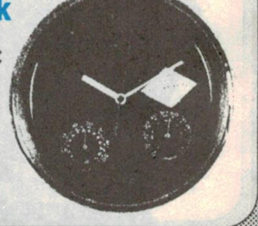
ONLY
$8.95

Energizer Weather Watch Wall Clock

Quartz clock movement
Thermometer from -20°C to 50°C
hygrometer from 0 - 100%
Guaranteed for 3 years
Great gift idea

All this for $29.95

Cat. XC-0120



Construction Project:

Tester for IR remote controls

Fixing a remote control unit for a TV or video cassette recorder is only half the problem: how about testing it? With this simple but very effective project, any remote control unit, including the older style ultrasonic types can be tested. The unit gives visual and audible confirmation that the control is transmitting, is battery powered, and is very simple to build. Just the shot for the serviceman and the 'handy' enthusiast.

by PETER PHILLIPS

These days, almost all VCRs and TV sets are operated using a remote control. In fact, some of the more up-market TV sets rely on the remote control, and only have a limited range of front panel controls that allow the user to 'get by' should the remote control fail. Most remote control units use an infrared beam to transmit the signal, via a bank of infrared LEDs. Great when they work, but very difficult to test when they are on the work bench – as infrared LEDs give no visible indication when operating.

Some might argue that a faulty remote control unit is best fixed by replacing it with a new one, testimony to the success of the 'throw it away' attitude promoted by manufacturers. But being one who hates waste, I recently repaired the remote control unit for the family TV set. Apart from the high cost of a new one, the unit was simply suffering that well known malaise known as 'kids'.

The fault was more mechanical than electrical, in that the 'sound up' button was no longer contacting. Otherwise everything else worked properly, including all the more 'useless' functions. I mean, why do some TV manufacturers assume you will buy their brand of VCR as well? Nearly half the buttons on the remote unit were for a VCR, and none of these were of any use. Except, that is, to fix the unit.

By 'borrowing' a button from the VCR section of the remote unit I was able to solve the problem. But not without numerous trips up and down the stairs, to see if the unit worked by testing it on the TV set.

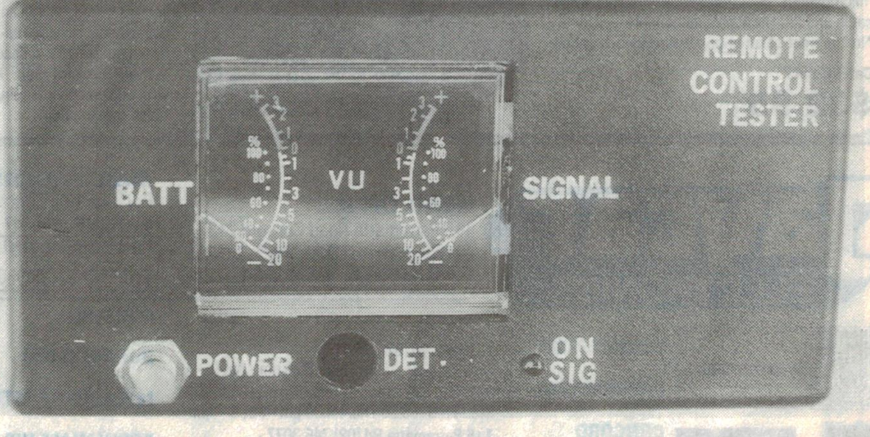
When Branco Justic from Oatley Electronics sent me this project, it was several weeks too late to help with my particular problem. But maybe not too late for many readers, who may be in the same dilemma that I faced. The point is, many remote control transmitter units can be fixed, and a means of testing them makes the job so much easier.

The project

The tester is battery powered, and automatically turns itself off after approximately two minutes. The battery will therefore last for around 12 months or more, depending on its shelf life. A disposals-type twin VU meter is used to indicate the battery voltage on one meter (left channel) and the strength of the signal from the remote transmitter on the other.

A small piezo type speaker gives an audible indication of the signal, in which the actual data stream from the remote control is heard as a sound. This way, if the remote unit is operating the transmitting LEDs without modulating them, the meter will indicate, but no sound will be heard. And if all else fails, a LED indicator also shows the signal strength. This LED can double as the power-on indicator, in which the normal brightness increases in the presence of a signal.

The signal from an infrared remote control transmitter is picked up by an infrared detecting diode, and an optional ultrasonic receiver can be added if required. The whole thing is built on

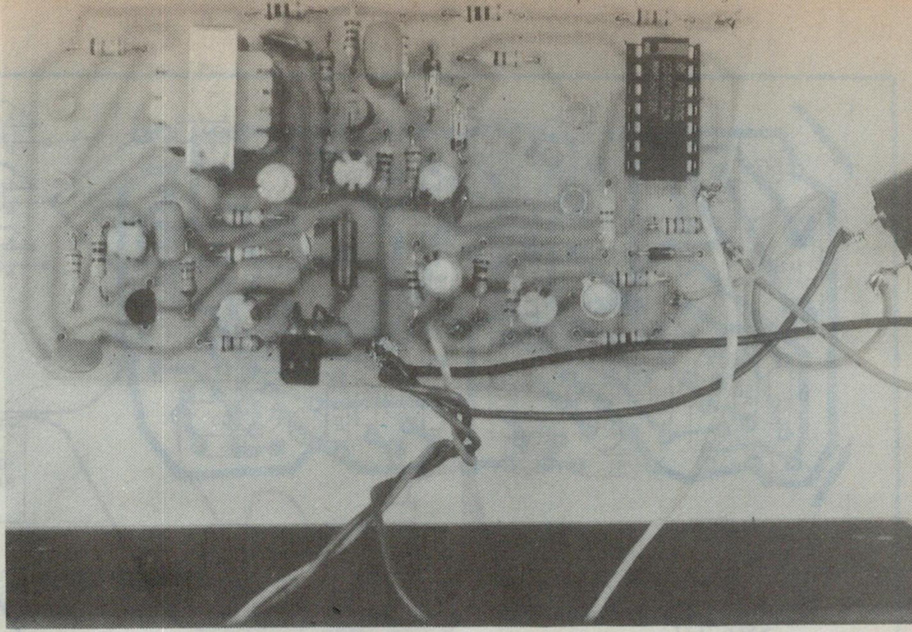


This neat little project can be used to test virtually any infrared remote control unit used with a VCR or a TV set. Fit an ultrasonic receiver and it will test ultrasonic remote controls as well.

a single PCB and is packaged into a jiffy box. The only front panel control is the pushbutton that turns on the power, making a neat little unit that will prove indispensable when servicing a remote control.

Although the unit can be built from bits and pieces from the scrap box, the easiest way is to buy it as a kit from Oatley Electronics. The cost of the complete kit which includes the meter, PCB and all the components is $34.90, but the hard to get parts (meter, transformer and PCB) can be purchased separately. See the end of the article for details.

Before describing this neat little tester, first a brief look at TV and VCR remote control systems in general.



This photo shows the PCB with the meter movement removed. The infrared detecting diode is mounted over C2, with the leads formed to a right angle so the diode faces up.

IR remotes

The principle of operation of most infrared remote control transmitter units is fairly standard, and involves an LSI IC, a matrixed keypad and the output LEDs. When a key is pressed, the IC produces a code sequence comprising a number of pulses, positioned within the code depending on which key is pressed. In other words, a binary number is generated, represented by a pulse for a logic 1 and a space for a logic 0. The number of possible codes depends on how many pulse positions (or bits in the number) are available, and an eight-bit code can produce, theoretically, some 256 codes. Most units generate codes with over 14 or 15 bits, although only a few codes, equal to the number of keys on the keypad, are actually used.

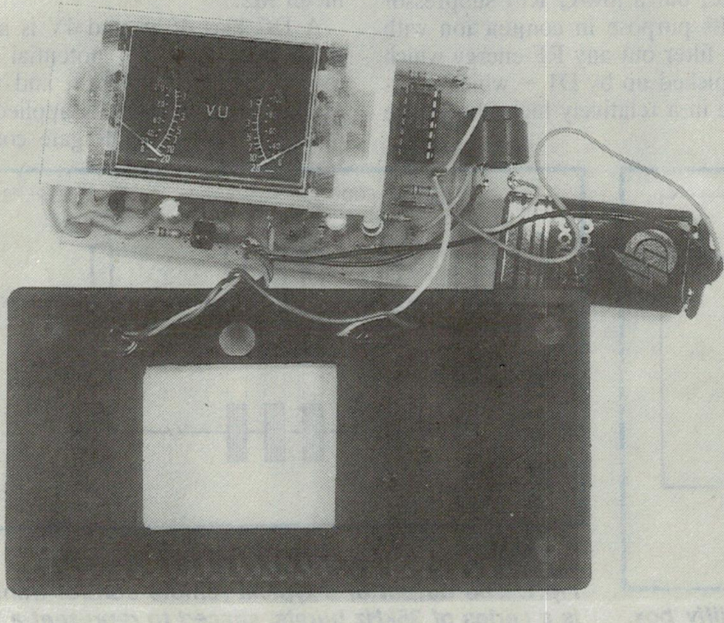
The width of each pulse is controlled, as the space between adjacent bits is important to allow a logic 0 to be transmitted. For example, as shown in Fig.1, a typical signal might contain pulses of 0.5ms width, with a space between each bit of 0.5ms, giving a cycle time of 1ms. A logic 0 between two logic 1's therefore equals a space of 1.5ms, while the space between adjacent logic 1 signals is 0.5ms.

Generally, while the key is pressed the code will be repeated, with each code spaced several milliseconds apart. In order that the code can be actually transmitted, an oscillator, typically running at 35kHz is keyed on and off by each pulse. Thus, the transmitted signal is a series of 35kHz bursts, and each logic 1 in the signal comprises several cycles of the 35kHz signal. For the example of Fig.1, there will be 17.5 cycles of the 35kHz signal for each output pulse that represents a logic 1.

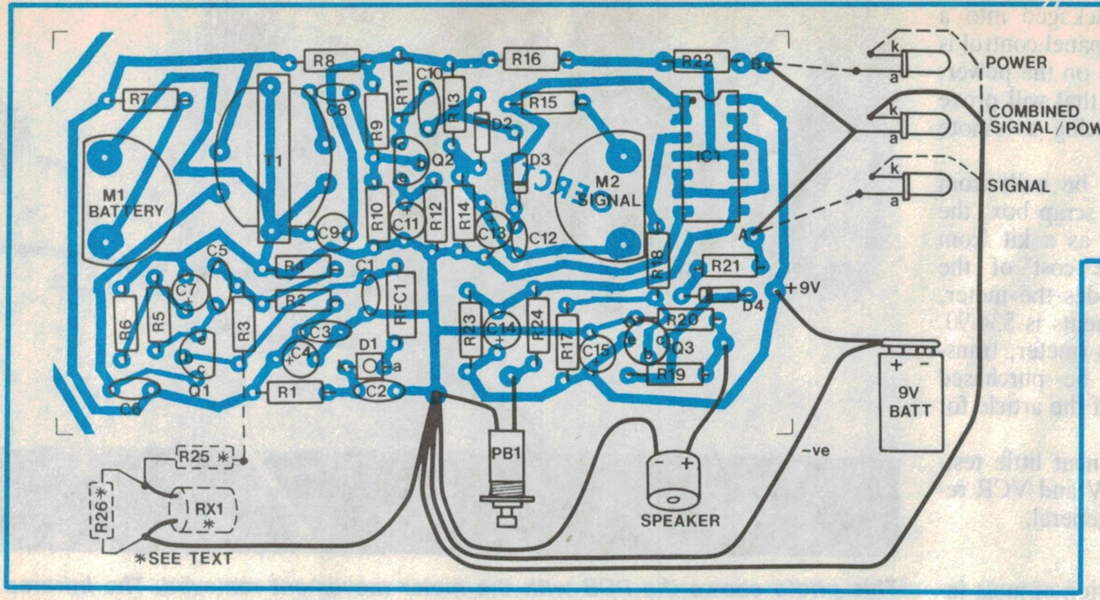
The task of the transmitter is to send out these bursts of 35kHz carrier, and the infrared LEDs are therefore actually turning on and off at this rate. To conserve battery power, some transmitter units send out the code for a few seconds only, even though the key is being pressed continuously. A simple test is to cover the transmitting LEDs, then to press a key. If the LEDs are now uncovered and the receiver fails to respond, the transmitter is one of these types.

The receiving section has to pick up the relatively weak infrared beam, amplify it, then detect the 35kHz carrier to reconstitute the transmitted code. A decoder IC then takes the code and activates the selected function. The beam is picked up by an infrared detecting diode, usually mounted behind an infrared filter, and the high gain amplifier will typically be situated close to the diode.

Prior to the development of infrared units, the ultrasonic principle was used. Some readers may even remember the totally mechanical units used on some brands of Admiral TV sets. These rather simple units used a hammer attached to each key, in which a key press caused an ultrasonic output by the hammer striking a tuned reed. The receiver section had filters to differentiate be-



This shot shows the complete assembly with the meter movement in place.



The layout diagram. The transformer has the primary winding (least resistance winding) on the left. All wires to the common line connect to the same point. Link points A and B if a single indicating LED is used.

tween each sound, and several functions were available, such as on-off, channel up or down and so on.

The ultrasonic units found on TV sets dating around the early 1970's used a pulse code system similar to the infrared units used today. However, their reliability and sensitivity was not as good as the infrared types, and they are now virtually obsolete.

Now that the basic operating principle of an infrared or ultrasonic remote control transmitter has been described, we can look at the circuit of the tester. Obviously it has to perform a similar function to the receiver section located in the TV or VCR, except the transmitted code now does nothing, except deflect a meter pointer, bleep a speaker and light a LED. Here's how the unit works...

Circuit details

The circuit contains an amplifier section, signal detector, meter drive circuitry and the power on-off logic. The signal from the remote control transmitter is received by D1, an infrared detecting diode.

If the optional ultrasonic receiver is fitted, an ultrasonic sound source will be received by RX1, a 40kHz ultrasonic piezo receiver. The receiver is coupled to the base of Q1 by R25, and to prevent oscillation, the RX1 is loaded by R26.

The output of D1 is filtered by RFC1 and C1, the junction of which connects to Q1. This transistor is bootstrapped by C5 to give a high input impedance for the amplifier associated with Q1. The reduction in gain due to the loading created by the optional ultrasonic transducer is not noticeable, and for this reason, it may be left connected without affecting the operation of the unit.

Incidentally, RFC1 is not a normal RF choke, but a low-Q RFI suppressor device. Its purpose in conjunction with C1, is to filter out any RF energy which may be picked up by D1 – which operates here in a relatively high impedance mode.

The output of Q1 is connected by transformer T1 to the common emitter amplifier around Q2. The transformer has a low Q and a bandwidth of around 100kHz, and, in the prototype, is a driver transformer from the horizontal output stage of a Pye TV receiver. While an audio transformer may work in this application, the relatively high bandwidth, (and low Q) of this particular transformer allows it to handle the signals from a wide range of remote control units.

The output of T1 is connected to the common emitter amplifier Q2, which drives the detector circuit comprising D2, D3 and C12. This circuit reconstitutes the data and the charge on C12, which is proportional to the signal strength, drives the signal strength meter M2.

A DC bias of around 4V is added to the signal by the potential divider formed by R13 and R14, and the sum of these two voltages is applied to the input of IC1a, a NOR gate configured

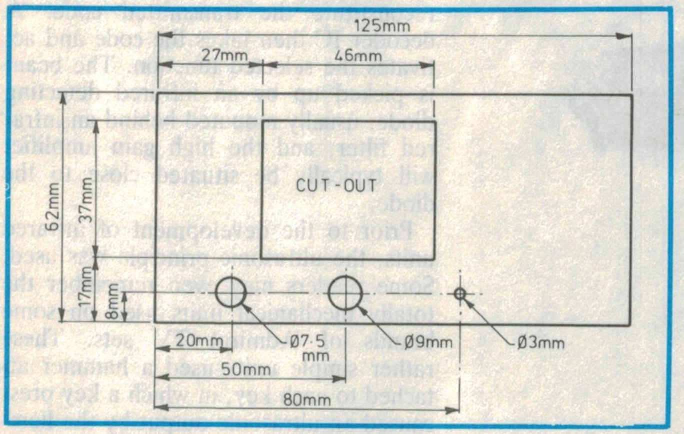


Fig.2: Use these measurements to cut out the jiffy box. Take care when drilling to avoid cracking the plastic.

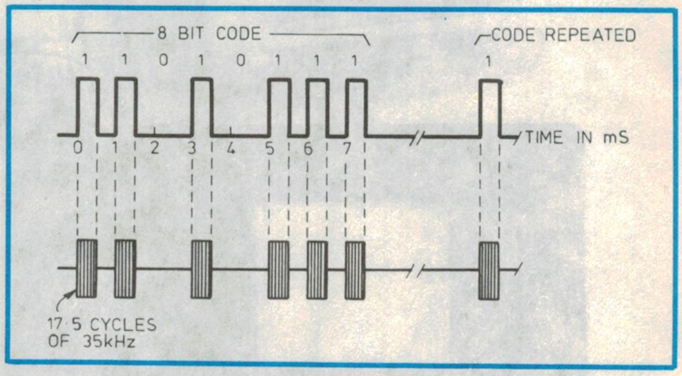
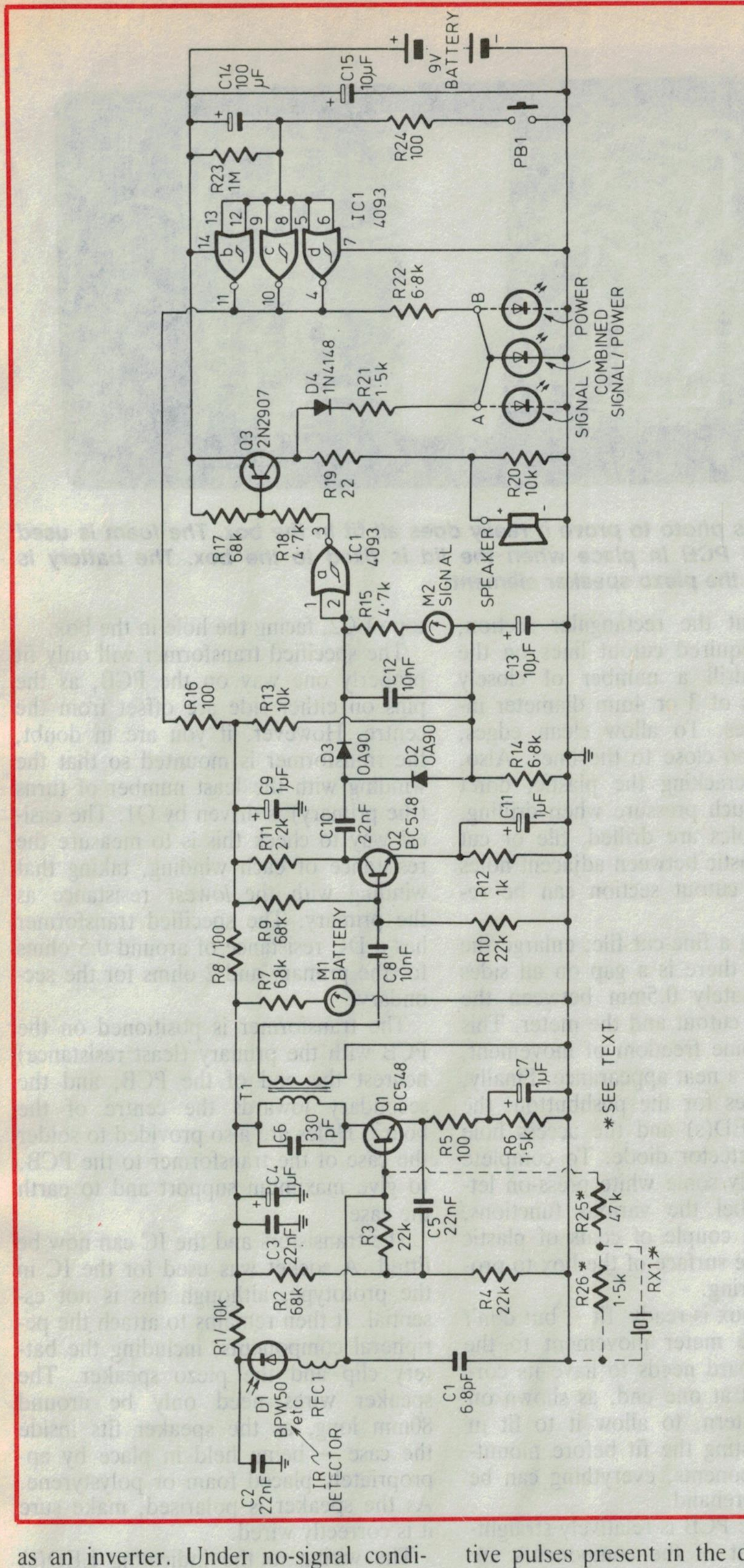


Fig.1: The output of a typical remote control transmitter is a series of 35kHz bursts, spaced to represent a logic 1 or a logic 0.



The circuit diagram. Information is received by D1, then amplified by Q1 and Q2. The 35kHz carrier is detected by D2 and D3, which drive the signal strength meter. Power to the circuit is switched on by IC1b-d, for a time interval determined by C14 and R23.

as an inverter. Under no-signal conditions, the output of IC1a will equal the supply rail of 9V, as the DC bias at its input is seen by the gate as a logic 0. The output of IC1a is connected to the base of Q3, via R18 and this transistor, which drives the piezo speaker and the signal indicator LED, will be off.

When signal is present, the output of IC1a will become low during the positive pulses present in the data, and Q3 will be driven on. Thus, the speaker will sound for each positive pulse and the signal LED will light.

As shown on the circuit diagram, there is an option to have either two LEDs – one to indicate power-on and another to indicate signal strength – or a single LED to indicate both functions. If the latter method is used (as in the prototype), points A and B are both connected to a single LED. Otherwise, separate LEDs are used, driven independently from point A and point B.

The power switch to the circuit is the network comprising gates IC1b-d, resistors R23 and R24, capacitor C14 and the pushbutton. Normally, timing capacitor C14 is held in the discharged state by R23. The voltage applied to the inputs of IC1b-d equals the supply voltage minus the charge on C14, which under these conditions, gives 9V minus 0V, which equals 9V. The outputs of the parallel connected gates will therefore be a logic 0, and no voltage is supplied to the circuit.

Because zero volts is applied to the input of IC1a, its output will be 9V, holding Q3 off as well. The only current being consumed by the circuit will be the supply current to IC1, which will be virtually zero, as this IC is a CMOS device.

When the button is pressed, C14 will quickly charge via R24, and the voltage to the inputs of the gates IC1b-d will drop to around zero. These gates will then give an output of virtually 9V, supplying the front end of the circuit with power. Output transistor Q3 can now be driven as already described, assuming an input signal is present.

The circuit current is around 3mA, rising slightly when a signal is present. The only current supplied by the gates is that to power the front end of the circuit, and the parallel combination of the gates gives the necessary drive capability. When capacitor C14 discharges sufficiently, the voltage at the input of the gates will become a logic 1 (at around 4.5V) and the circuit will switch off. For the values shown, a delay of approximately 2 minutes is provided, and changing the values of either C14 or R23 will alter this value.

The remaining resistors and capacitors provide filtering and decoupling of the power supply line. The battery voltage indicator is meter M1, driven via R7, and the power indicator LED is supplied by R22. Diode D4 isolates the collector of Q3 from the DC voltage at point B.

Construction

The unit is designed to fit inside a medium sized jiffy box, and it may be best to prepare the box before constructing the PCB. Fig.2 gives details of the cutout and the holes required on the bottom of the box. If you elect to use two separate LEDs for power and signal indication, then an extra 3mm hole will be required.

PARTS LIST

1 PCB, 101 x 55mm, coded OERCT
1 9V battery clip
1 Single pole, momentary-on pushbutton
1 Transformer (see text)
1 Dual VU meter movement
1 Piezo speaker element
1 RF suppressor (see text)
1 Jiffy box, size 41 x 68 x 130mm
1 14-pin IC socket
Hook up wire

Resistors

All 1/4W, 5%:

R1,13,20	10k
R2,7,9,17	68k
R3,4,10	22k
R5,8,16,24	100 ohm
R6,21,26	1.5k
R11	2.2k
R12	1k
R14,22	6.8k
R15,18	4.7k
R19	22 ohm
R23	1M
R25	47k

Capacitors

C1	6.8pF ceramic
C2,3,5,10	22nF polyester
C4,7,9,11	1uF electrolytic
C6	330pF ceramic
C8,12	10nF polyester
C13,15	10uF electrolytic
C14	100uF electrolytic

Semiconductors

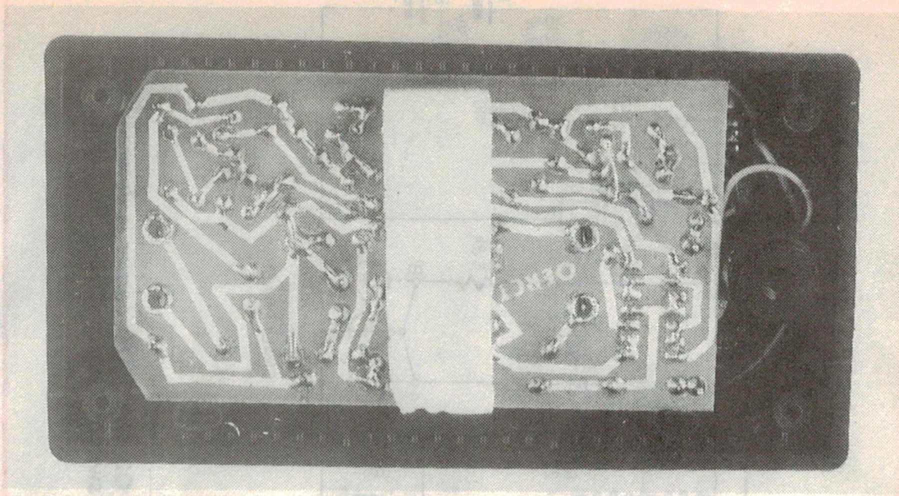
D1	BPW50 infrared detector diode
D2,3	OA90 signal diode
D4	1N4148 diode
Q1,2	BC548 NPN transistor
Q3	2N2907 PNP transistor
IC1	4093 quad Schmitt input NOR gate
RX1	EFR-RSB40K2 ultrasonic receiver (see text)

3mm red LEDs (see text)

Kits of parts for this project are available from:

Oatley Electronics,
5 Lansdowne Parade,
Oatley West, NSW 2223.
Phone (02) 579 4985
Postal address (mail orders):
PO Box 89, Oatley West NSW 2223.

Complete kit, excluding ultrasonic receiver *$34.90*
Post and packing *$3.00*
Meter and transformer only *$12.00*
PCB *$7.00*
Speaker element *$2.50*
Ultrasonic receiver *$5.00*



We took this photo to prove it really does all fit in the box. The foam is used to hold the PCB in place when the lid is fixed to the box. The battery is underneath the piezo speaker element.

To cut out the rectangular section, mark the required cutout lines on the box, then drill a number of closely spaced holes of 3 or 4mm diameter inside the lines. To allow clean edges, don't drill too close to the lines. Also, to prevent cracking the plastic, don't apply too much pressure when drilling. Once the holes are drilled, file or cut away any plastic between adjacent holes so that the cutout section can be removed.

Then using a fine-cut file, enlarge the hole so that there is a gap on all sides of approximately 0.5mm between the edges of the cutout and the meter. This will allow some freedom of movement, and still give a neat appearance. Finally, drill the holes for the pushbutton, the indicating LED(s) and the access hole to the IR detector diode. To complete the job, apply some white press-on lettering to label the various functions, then apply a couple of coats of plastic lacquer to the surface of the box to protect the lettering.

Once the box is ready, fit – but don't solder – the meter movement to the PCB. The board needs to have its corners trimmed at one end, as shown on the PCB pattern, to allow it to fit in place. By testing the fit before mounting the components, everything can be trimmed beforehand.

Loading the PCB is relatively straightforward. Most of the components are under the meter movement, so obviously it should be fitted last. As usual, mount and solder the resistors, capacitors and diodes first, taking care with the orientation of the diodes and the electrolytic capacitors. The IR detecting diode D1 mounts behind C2, and is arranged so that when its leads are bent at a right angle, the diode sits over the top of C2, facing the hole in the box.

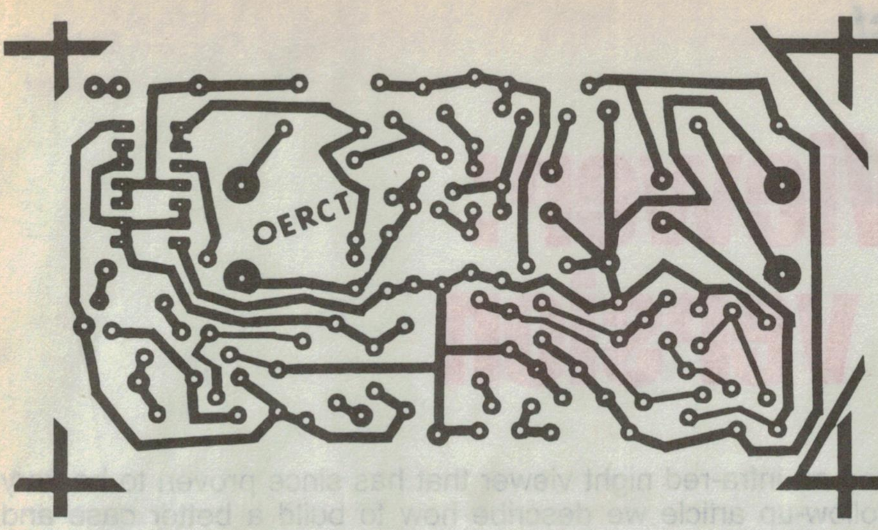
The specified transformer will only fit properly one way on the PCB, as the pins on either side are offset from the centre. However, if you are in doubt, the transformer is mounted so that the winding with the least number of turns (the primary) is driven by Q1. The easiest way to check this is to measure the resistance of each winding, taking that winding with the *lowest* resistance as the primary. The specified transformer has a DC resistance of around 0.5 ohms for the primary and 2 ohms for the secondary.

The transformer is positioned on the PCB with the primary (least resistance) nearest the end of the PCB, and the secondary towards the centre of the board. Holes are also provided to solder the case of the transformer to the PCB, to give maximum support and to earth the case.

The transistors and the IC can now be fitted. A socket was used for the IC in the prototype, although this is not essential. It then remains to attach the peripheral components, including the battery clip and the piezo speaker. The speaker wires need only be around 80mm long, as the speaker fits inside the case – being held in place by appropriately placed foam or polystyrene. As the speaker is polarised, make sure it is correctly wired.

The wiring to the indicating LED(s) and the pushbutton is the last task, and is best performed before these components are attached to the box. Note that all the common wires connect to the same point on the PCB.

If you intend fitting a piezo receiver for testing ultrasonic remote controls, you will need to place it and the two associated resistors off the PCB. Follow



The PCB pattern is shown here full size for those wishing to make their own.

the circuit diagram for details, and mount R26 on the terminals of the receiving element. The connecting pin attached to the case of the receiver should be connected to the common terminal of the PCB, along with the other wires already sharing this terminal. Keep the wiring to the receiving element as short as possible, as the sensitivity of the circuit may cause oscillation under certain circumstances.

Finally check over the job for any soldering or component mounting errors, then fit and solder the meter movement in place.

Testing

Once you are sure that all is finished, attach a 9V battery to the battery clip and press the pushbutton. The power-on indicating LED should light, and the battery voltage indicating meter should show approximately 0dB, or just below the red section on the scale.

Then, using any infrared remote control transmitter, press one of its buttons and point the transmitter at the IR detector on the PCB. If the tester is working correctly, the speaker should sound, the power-on/signal LED should glow more brightly and the signal meter should show an indication. The degree of deflection will depend on the strength of the signal from the transmitter, and a typical unit will give an indication of around 0dB on the meter.

The tester should respond to a transmitter held up to 200mm or so from the IR detecting diode, although this will also depend on the output level of the transmitting unit. We were unable to fully test the ultrasonic option, due to the lack of a suitable transmitter, but the tests we were able to do suggest that the signal strength indication may not be as strong as that from an infrared type.

By now, the timer should have turned the power off, and if you think the time allowed is insufficient, change the values of either R23 or C14. The prototype gave a time delay of approximately two minutes, which is really all you need for test purposes. If you want total control, fit a toggle switch in place of the pushbutton. Just remember to turn it off after use!

Final assembly

If everything works correctly, the whole unit can now be assembled. Otherwise, start checking with a voltmeter and a 'scope to remedy any problems. As a guide, a signal like that shown in Fig.1 should be visible at the collectors of Q1 and Q2, and at pin 3 of IC1. Note that the meter movement must be connected for the data to appear at pin 3 of IC1 and for the speaker to sound.

The LED can be either glued in place or held by spot melting the plastic around the hole holding the LED. Then with the pushbutton and the LED firmly in place, fit the PCB assembly into the box. The battery and the speaker are then arranged next to the PCB. To hold everything in place, use small blocks of foam between the PCB and the lid of the box. It all fits, but only just.

There is no need to fit an infrared filter, but make sure the IR detecting diode is central to the hole in box. To increase the sound output from the speaker, drill a pattern of holes on the lid of the box, above the speaker element. And that's it – a neat and very useful item of test equipment in these days of the remote control.

IR Night Viewer: the 'Pro' version

In the May 1990 issue, we presented an infra-red night viewer that has since proven to be very popular with constructors. In this follow-up article we describe how to build a better case and lens system, which combined with the fully proven electronics makes this project a truly professional article. As well, we answer a few questions that readers have posed about this project.

by PETER PHILLIPS and RON EDWARDS

The development of the IR viewer, described in the May 1990 edition of *EA*, required a circuit able to deliver high DC voltages with good regulation from a 9V battery. This was a difficult task, which left little time for the development of a professional quality case and lens system. But since May, the response to the project has been sufficient to warrant another look at the mechanics of the project.

Although the case and lens system originally described is adequate, the bulkiness of the case and the simplicity of the lens are limitations that detract from the appearance and quality of the project. Also, many readers have wondered what the viewer screen actually *shows*. Perhaps our description was inadequate, something we now hope to remedy.

As our lead picture shows, the new case (which is fully described in this article) certainly looks the part. In fact it is hard to believe it is homemade. Contrast this case with the old design, and you can see why we are so excited; it certainly demonstrates how a few commonly available bits and pieces can be used to good effect. Add to this an improved lens system, which is also described, and the end result puts the whole project into the 'professional' league.

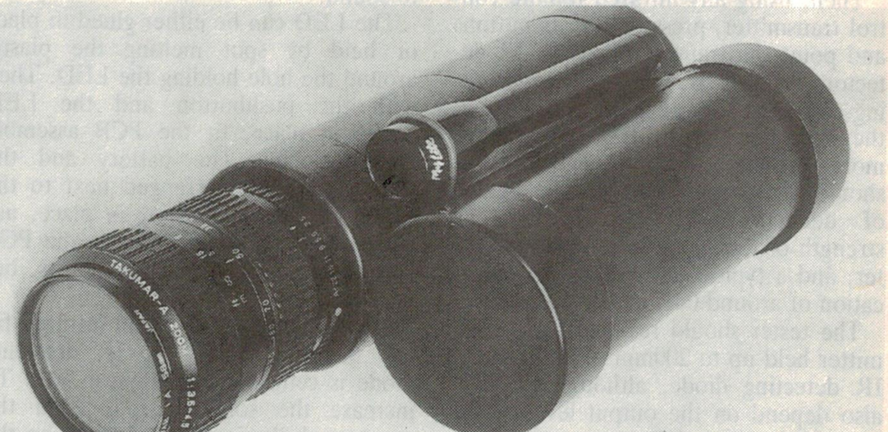
Before describing the new case and lens system, first an answer to the commonly asked question concerning the type of display shown on the screen of the IR viewer tube. The photo of Fig.1 is an actual shot taken of the screen while the viewer was pointed at a bookcase in the corner of a darkened room. As you can see, the image on the screen is rather like that of a small TV tube.

The detail depends on how well everything is focused, and as the photo shows, excellent results are possible. Unfortunately, some of the resolution of the original photo has been lost in the process of reproducing it in the magazine, but the end result still shows the type of image displayed by the tube. Quite simply, you see a full picture, not some sort of outline or hazy glow.

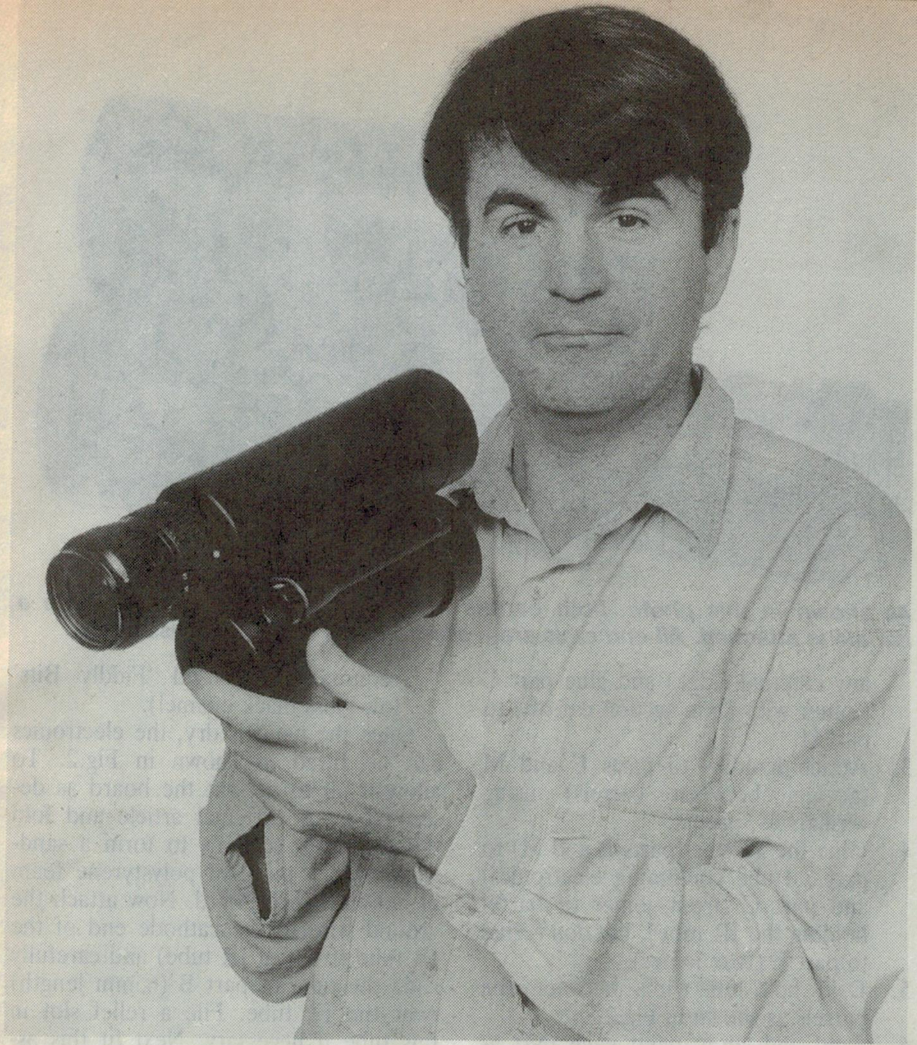
The new case

The new case is constructed with 65mm PVC tubing, matching joiners and end caps. These are all available from plumbing suppliers or larger hardware shops. There are two types of end caps available, and the grey coloured caps are recommended instead of the thinner black types. If you don't wish to source these items, Oatley Electronics, the designers of the original project are planning to stock a kit of parts for the case, at an approximate cost of $27.

After construction, the assembly is sprayed with a black enamel paint, giving a final result that is not far short of excellent. As the photos show, a single handle was fitted to the case, but we suggest fitting two handles attached to the gussets described as parts L and M in Fig.2. This will allow for left- or right-handed use, and the infrared torch can be attached to the unused handle.



It's hard to believe, but this all new case for the infrared night viewer is home made. Add a 35mm telephoto lens to the case and the result is a truly professional piece of equipment.



This photo shows Branco Justic from Oatley Electronics, looking justifiably pleased with the results of the new case.

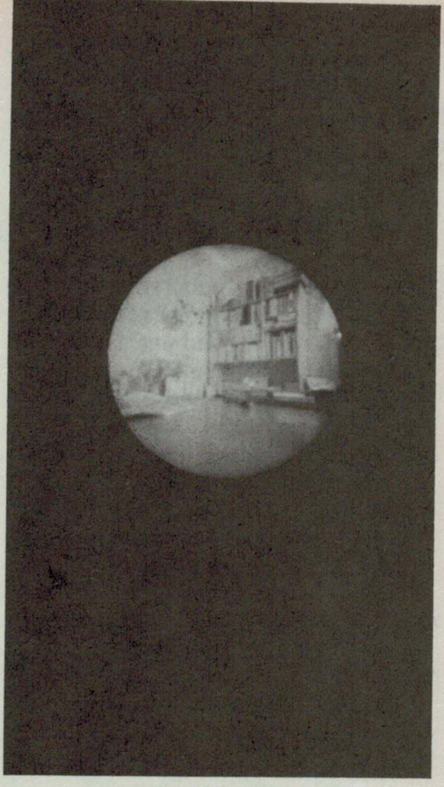


Fig.1: This photo was taken by placing a camera close to the unmagnified screen of the IR image tube. The room was darkened considerably, but the display is quite clear and well defined. In absolute dark, the display is similar to this photo, although an infrared torch is required to light up the area being viewed.

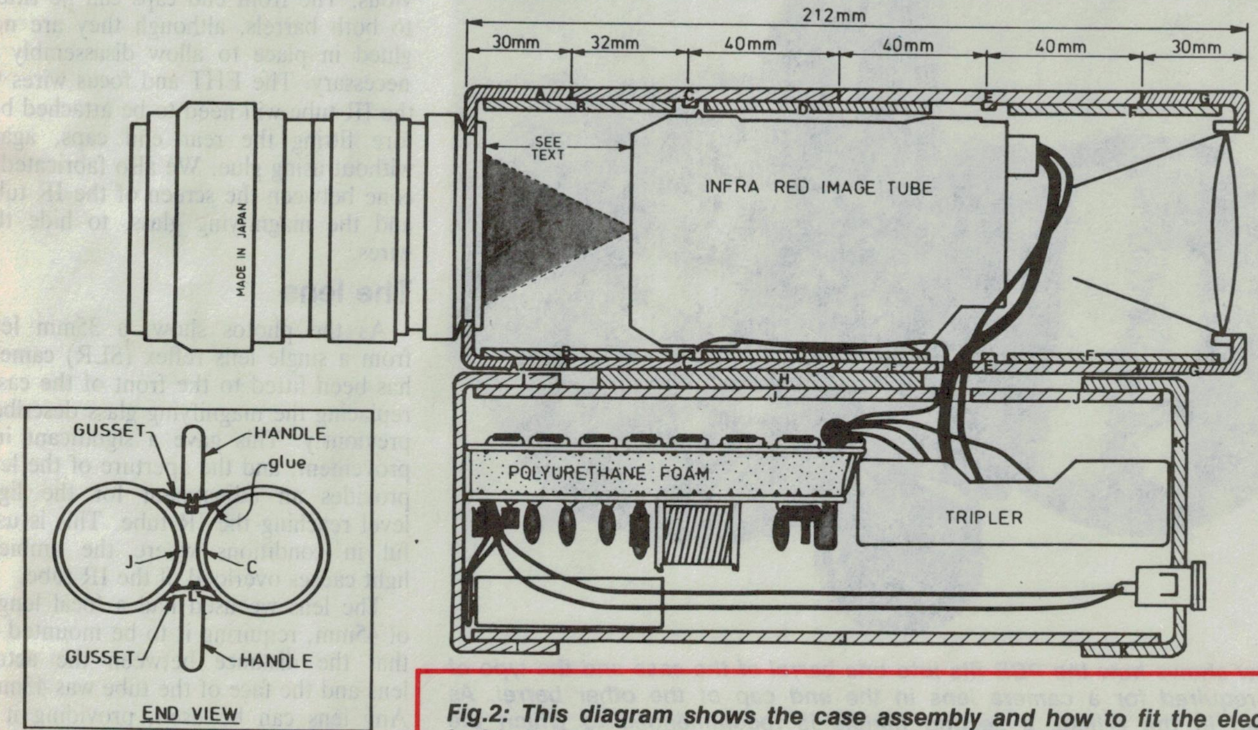


Fig.2: This diagram shows the case assembly and how to fit the electronics inside it. Refer to the parts list for details of each section.

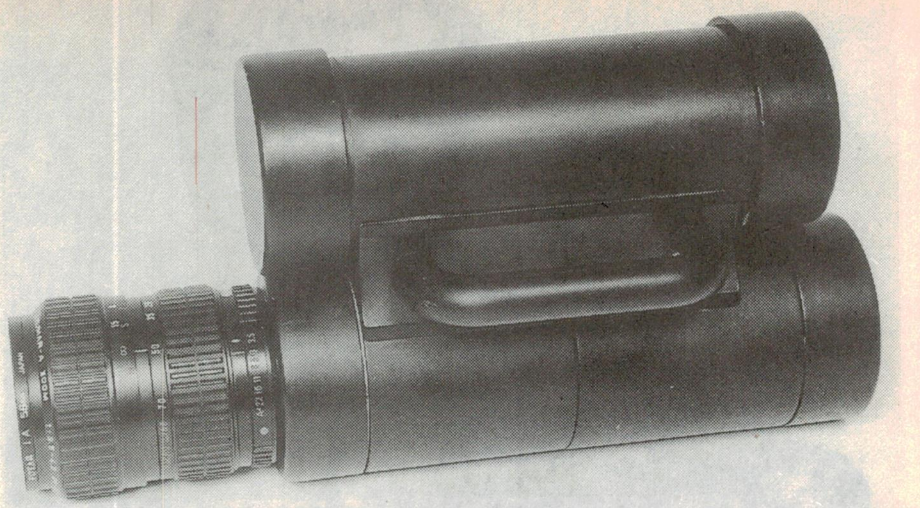
IR Night Viewer

Construction is mainly a matter of following the diagram of Fig.2. The procedure to construct the case is basically as follows:

1. Cut the 65mm PVC tube into the four specified lengths (parts B, D, F and J).
2. Slice three C section strips, two as connecting pieces between barrels (parts L and M) and one as a spacer between barrels (part H).
3. Cut 8mm off the end of one joiner (part C).
4. Cut a hole in one end cap for the lens at the viewing end. (54mm for K-Mart lens).
5. Cut a 45mm hole in another end cap with three notches to 48mm to suit a camera lens.
6. Drill a hole for the power switch in another end cap.
7. File or cut relief slots for wires in tube of part D and joiner (part C) to suit the IR tube being used.

When all the pieces are cut, assembly can be done in the following way:

1. Glue (with clear PVC conduit glue) part H (spacer) to part J (tubing holding electronics). Position part H at least 25mm in from the end of part J.
2. File or sand the joiners to remove any external ridges and glue part C (joiner with 8mm section cut off) to part H.
3. Attach handles to parts L and M (gussets between barrels) using washers as spacers.
4. Glue the gussets (parts L and M) to part J (tube containing electronics) and part C (front joiner of barrel holding the IR tube), but *don't* glue to part E (rear joiner).
5. Drill hole for wires between the barrels as shown in Fig.2.
6. Sand and spray paint each part as required. (We used 'Fiddly Bits' low-gloss black enamel).



As shown in this photo, both barrels are joined with a gusset to which a handle is attached. All end caps are a press fit only to allow disassembly.

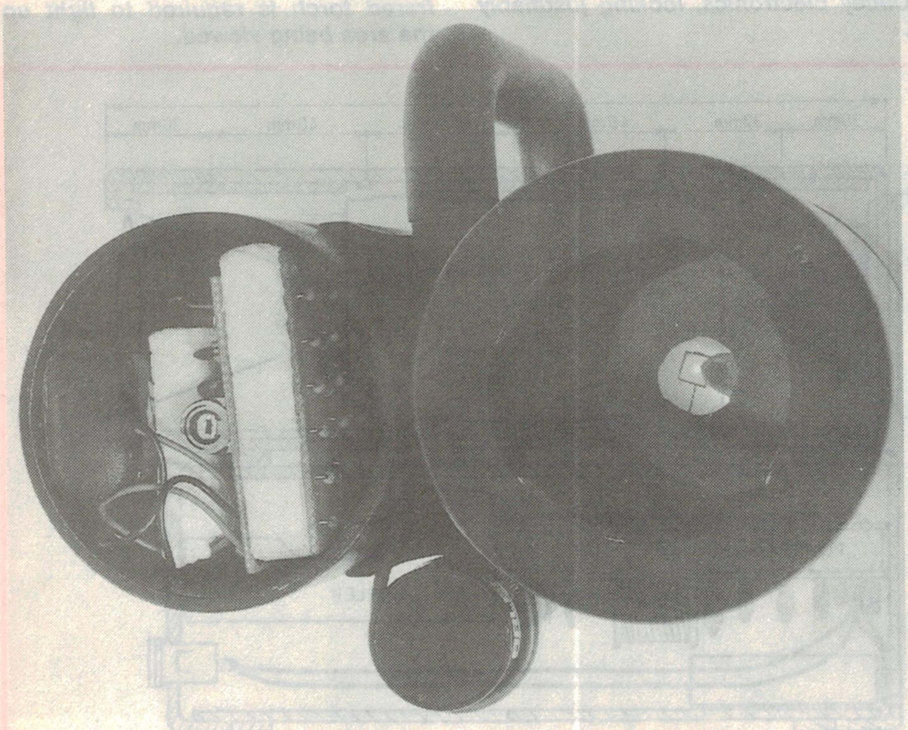
Once the paint is dry, the electronics can be fitted as shown in Fig.2. To allow it all to fit, cut the board as described in the original article and fold the two PCB sections to form a sandwich, with a piece of polystyrene foam in between each board. Now attach the ground wire to the cathode end of the IR tube (front of IR tube) and carefully slide the tube of part B (65mm length) over the IR tube. File a relief slot in this tube if necessary. Next fit this assembly into the joiner of part C, again filing any necessary reliefs for the wire.

The rest of the assembly is fairly obvious. The front end caps can be fitted to both barrels, although they are not glued in place to allow disassembly if necessary. The EHT and focus wires to the IR tube will need to be attached before fitting the rear end caps, again without using glue. We also fabricated a cone between the screen of the IR tube and the magnifying glass, to hide the wires.

The lens

As the photos show, a 35mm lens from a single lens reflex (SLR) camera has been fitted to the front of the case, replacing the magnifying glass described previously. This gave a significant improvement, and the aperture of the lens provides an adjustment for the light level reaching the IR tube. This is useful in conditions where the ambient light causes overload of the IR tube.

The lens we used had a focal length of 45mm, requiring it to be mounted so that the distance between the actual lens and the face of the tube was 45mm. Any lens can be used, providing it is spaced from the front of the tube by its



This view shows how the PCB fits into one barrel of the case and the type of cutout required for a camera lens in the end cap of the other barrel. As described in the article, a second handle is recommended to which the infrared torch can be attached.

focal length. In case you aren't sure, Fig.3 shows how to measure the focal length of a lens.

The infra-red torch

The original article described how to make an infrared torch using a conventional D-cell type torch. As shown in the photos, a smaller type of torch has been fitted to the case. As already described, the torch can be attached to one of the handles using rubber bands. Most electronic parts suppliers stock these types of torches.

Technical update

As mentioned in the original article, different types of IR image tubes can be used. Oatley Electronics is sourcing tubes as they become available, including some made by ITT. One version doesn't require a focus lead, as the tube is self-focusing, while another has leads already attached to the tube. Oatley Electronics includes relevant details about the tube supplied with a kit.

Another minor change is a different tripler to that described originally. The new tripler completely removes any shimmering of the image, and requires an extra connection (to ground) as it contains the high voltage filter capacitor previously fitted to the PCB.

Our warning about X-ray emission was probably unnecessary, as the tubes being supplied all work at less than the 25kV level necessary to produce X-rays. Early model IR tubes required this type of voltage, prompting our warning in the first place.

And finally, the PCB has been changed to allow each focus resistor to be mounted singly, rather than as a series string. So all in all, the night viewer has undergone a few electrical changes, but has been reborn mechanically. A marvellous project that's now even better!

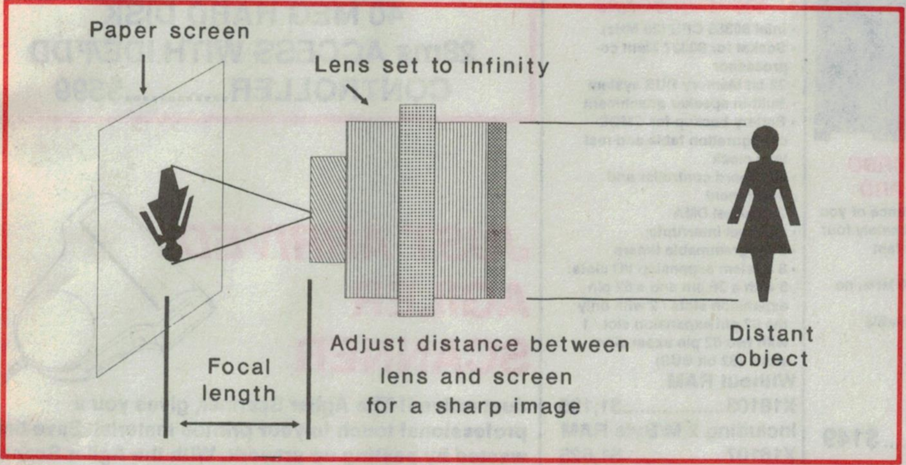


Fig.3: To measure the focal length of a lens, move the screen displaying the projected image to obtain a sharp picture. The focal length is the distance between the screen and the lens face.

The Philips IR image tube is a neat fit, as this photo shows. A relief slot cut inside the case is required to accommodate the cathode lead which connects to the other end of the tube.

PARTS LIST: CASE

- A End cap for 65mm tubing with cutout to suit camera lens.
- B 50mm length of 65mm dia PVC tubing. Make longer to suit focal length of lens.
- C Joiner for 65mm tubing. If focal length of lens is less than 53mm, shorten the joiner by 8mm at one end.
- D 60mm length of 65mm dia plastic tube. A relief groove may need to be filed to accommodate the cathode lead.
- E Joiner for 65mm tube.
- F 55mm length of 65mm tube. For greater magnification of the viewer screen, this tube can be up to 85mm long. If so, increase the length of section J accordingly.
- G End cap for 65mm tube with cutout for magnifying lens. A suitable lens can be purchased from K Mart or most stationary suppliers.
- H 85mm long by 12mm wide section of 65mm tubing as a spacer between each barrel.
- I End cap for 65mm tubing.
- J 185mm length of 65mm tubing. Refer to description of section F.
- K End cap for 65mm tube with hole drilled for power switch.
- L,M Gussets sliced from a length of 65mm tube, cut to a length of 130mm by 42mm wide. These are used to join both barrels of the case.

Kits of parts for the case are available from:

Oatley Electronics
5 Lansdowne Parade,
Oatley West, NSW 2223.
Phone (02) 579 4985

Postal address (mail orders):
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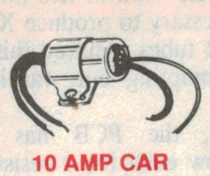

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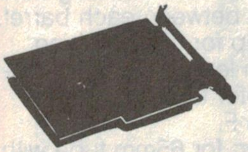

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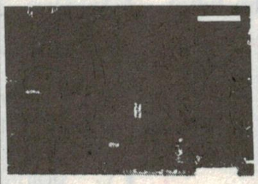

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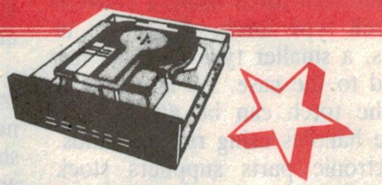

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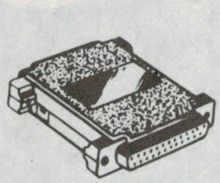

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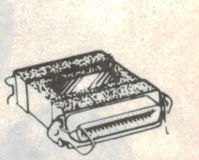

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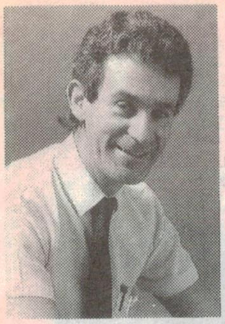


Information centre

Conducted by Peter Phillips

Projects and puzzles revisited

Project modification seems to be the main thrust this month, in which constructors describe solutions to fixing a bug or two in a range of projects from past years. As well, we revisit the May 'What??' question and extract some technical interest from a letter published last month.

Projects are often the main reason readers buy an electronics magazine, possibly for the challenge of their construction, but also for their cost effectiveness. We get a lot of letters about projects, and these pages provide the means of airing problems and (hopefully) the solutions. Project presentation is also a topic of interest, and the following letter offers an opinion that supports our philosophy on how to describe a project.

I have copies of EA dating back nearly 30 years, and I have enjoyed constructing many projects over this time. But the thing I most enjoy is the background explanations you provide for a project. I abandoned a competing magazine after finding it provided virtually no background theory, just a sort of 'solder all these parts onto this PCB and put them in a box' approach. Keep up the good work! (R.G., Gerringong NSW).

We couldn't agree more, as theory sweetened with a useful project is surely a good means of learning about electronics. It's also a good way of discussing details that would be lost in a textbook or a feature article. Of course, occasionally we hear of readers who are only interested in the nitty gritty of building the project, but most readers seem to prefer the full thing, as R.G.'s letter shows. This correspondent has also supplied some useful information on a project that has enjoyed a degree of popularity over the years, and has even sent me a rather neat computer program. First the project...

Electric fence mods

Some more input re the Electric Fence unit described in EA December 1985. This project has a 12V DC-DC inverter wound on a Philips FX2240 pot core, and various readers have described their troubles with the driver transistors failing in this circuit. It happened to my unit twice, and I eventually traced the problem to the pot core. Although I purchased the core, mounting clips and bobbin from the same supplier, I found that the bobbin was too thick to allow the core sections to meet, even when firmly pressed together. Replacing the bobbin with a slightly smaller one solved the problem – but, as it turned out, only for a week or so.

It was then that I discovered that the unit was delivering a spark well over 25mm long, and not having the time to investigate, I left it running in the interests of keeping my wife's garden free from roaming cows. The next time I checked there was no spark – only a burnt out coil, two open circuit driver transistors and a charred PCB.

After rewinding the coil (again!), I found that the spark was still excessive and that the dump capacitor was being charged to over 800V. No wonder it gave such a huge spark, as the circuit should regulate to around 280V. I eventually traced the problem to an open circuited 10M resistor in the feedback network, which when replaced, restored the unit to correct operation. I decided to use two 5M 1 watt resistors instead of the specified 10M 1/2W type, as it seems this rating is inadequate for the job. So far all is well, although a colony of black ants taking up residence on the PCB has since caused another failure.

In all fairness, the designer could not have foreseen either the ant or ill fitting bobbin problems. But the underrated resistor might have been anticipated. If only our fore-sight was as keen as our hind-sight. (R.G., Gerringong NSW).

And some Fourier

But R.G. sent two letters, the second including the bouquet about our project presentation and a program for an Apple computer that demonstrates Fourier analysis. The program uses graphics to show the effect of adding a number of odd harmonic sinewaves to the fundamental, in which a square wave results if sufficient harmonics are added.

The program is written in Applesoft Basic, and if any readers want a copy, please send a blank disk, and I will copy it for you. (Yes, I still keep my Apple computer warmed up, although perhaps not as hot as the IBM these days). And now we revisit the May teaser.

Thevenin and May's What??

The What?? question posed in May by Jack Middlehurst has drawn a few letters, with quite a few writers suggesting that the current in the 6-ohm resistor is 1 amp (assuming no internal resistance for the batteries). The logical (but erroneous) conclusion being made in some cases is that the current is therefore 0.5A per battery. I'll get back to that one, but first let's correct a couple of errors – one typographical and the other mathematical.

As one correspondent identified, the answers for the individual currents should have read 0.4762A, not 0.4672A. But, as several letters pointed out, the answer provided is incorrect anyway – typo or not. The correct answer is 0.4958A per battery. Perhaps the easiest way to show why is with the following letter, which also starts with a statement I disagree with:

It is perfectly valid to neglect the source resistance in a textbook type problem. On this basis, your poser in May can be solved by inspection, since E1 and E2 are effectively in parallel giv-

ing a current through the load of 1A.

However, I am surprised you did not invoke our old friend Thevenin to assist with the answer presented in June. As a gentle reminder to readers, Thevenin's theorem can be resolved into a simple series configuration using the following steps:

1. *Remove the load (Rl).*
2. *Calculate the open circuit voltage (V).*
3. *Calculate circuit resistance 'looking into' the open circuit load terminals with all voltage sources replaced with short circuits.*
4. *Redraw the circuit as a series configuration with the load resistor replaced.*
5. *The load current equals V/Rl.*

For the circuit shown in June, the answer is 0.992A. (W.M., Chatswood NSW).

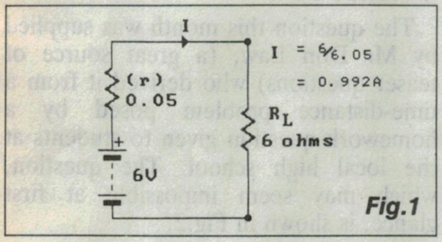


Fig.1

The Thevenin equivalent circuit is shown in Fig.1, which makes it all seem very simple. Other readers also came up with 0.992A as the total current, giving 496mA per battery. I checked this out using the equations provided by the contributor of the problem, and sure enough, the answers given were incorrect. I'm glad I'm not the only one who gets solutions wrong!

Now back to the point about having voltage sources with no internal resistance. True, the load current will be 1A, as Ohm's law predicts. But, if you read the original question it was stated that the individual currents are *not* 0.5A.

To explain why, assume you connect one 6V battery (with no internal resistance) across the 6 ohm load. OK, 1 amp of current will flow. Now get the other 6V battery, again with no internal resistance and connect it across the load – which is still connected across battery number 1.

There is no way you can determine how the current will be shared. Certainly the total will still be 1A, but the proportions are impossible to figure without introducing some value of series resistance for each voltage source. The basic principle of making parallel transistors equally share a load current is to introduce a series resistor in each parallel path. As the question asked for the individual currents, some value of series resistance must be present. Hence the statement that the load current is *not* 1A.

On this basis, the opening paragraph of the letter by W.M. is therefore incorrect. You cannot assume a zero source resistance, as an infinite range of answers is possible. And in an imperfect world, the notion of zero resistance is still a scientific dream anyway. Again my thanks to Jack Middlehurst for this question, as it was obviously tried by many readers.

Digital cap meter

One of the more popular projects produced by *EA* is the venerable digital capacitance meter, originally presented in March 1980. Since that time errata and extra notes have been published to solve the various problems inherent in the design. The following letter will therefore be of interest to anyone who has built this project, as the writer has spent a lot of time tracking down and solving some of the remaining problems:

Some years ago, I built the EA digital capacitance meter, and I recently decided to incorporate all the available errata to bring it up to scratch. My aim was to stabilise the display against jitter; but after doing all the modifications suggested, I found the lower digit still remained unstable on the microfarad range. There were also a number of other problems, and after much experimenting, I have finally overcome most of these. Perhaps you may like to share my findings with your readers.

The first thing I decided to investigate was the jittery display on the microfarad range. I traced this problem using a 'scope, and found that noise was present on pins 13 and 6 of IC2, perhaps due to either the 0.22uF capacitor or the diode. By connecting a 10pF capacitor between these pins and ground, the problem was solved. I also changed the 2.2M resistor to a 5M value, as this made the signal at these pins less prone to drift.

The modifications suggested changing the capacitor at pin 8 of IC3c from a 2.2nF to a 6.8nF, but as this made calibration of the pF range virtually impossible, I restored it to the original value of 2.2nF. It was also recommended that the resistor at S1a1 be changed to a 3.3k, but as this gives VR2 less adjustment, I used a 1.5k instead.

I found that VR3 could not be adjusted far enough to get a calibrated reading of less than 40pF, suggesting the value of VR3 to be incorrect. Using a 20k trim pot gave just enough range to get a calibrated reading of 0pF.

It would also seem that the MC14584 IC gives better results than a 74C14, as the latter gives a very 'nervous' display. In general, although the changes I've implemented have improved things, the project is still not perfect. Perhaps you might consider developing another digital capacitance meter, but this time one that reads above 99uF. (B.C., McKinnon Vic).

Many thanks for these suggested improvements, B.C., which I'm sure will be tried by many readers. We haven't got immediate plans for another similar project, mainly because commercial models are now so readily available. However, it's one to look into for the future.

He did feel it!

Last month I printed a story called 'I didn't feel a thing' that raised quite a giggle with staff at the magazine. Unfortunately in condensing the original contribution I got carried away with the humour, and forgot the real purpose of the story. As the contributor has since pointed out, the rewrite 'had no technical interest' and implied 'that I'm a drunk on occasions'. As technical content is really the purpose of these pages, here's the questions that should have been made more prominent:

Can you tell me if the secondary winding of a car ignition coil is returned to earth via to the terminal that goes to the contact breaker on the distributor. I reason that it should, because this way the primary back-EMF adds to the 'spark' voltage instead of subtracting from it. Also, do 'Old Timers' become inured to electrical stimulation and/or is alcohol an insulator? (D.L., Tumblong NSW).

The Kettering ignition system is certainly one of the cleverest things, and I recall getting quite involved in its analysis some years ago. I have never considered the aspect of the primary voltage adding or subtracting from the secondary voltage, but obviously, if there is a choice, then it should be additive.

I regard the secondary of the ignition coil as forming part of a resonant circuit, pulsed into oscillation every time the distributor points open. The capacitance of the tuned circuit consists of the stray capacitances of the coil and the load connected to it. The load consists of the lead to the distributor cap, the cap itself and the spark plugs with their leads. I suggest there is probably an optimal value for the total stray capaci-

tance, perhaps explaining why some cars run better with particular types of spark plug leads. The capacitor connected across the points probably comes into this as well, although its effective capacitance is transformed by the turns ratio of the ignition coil.

However, I may be totally incorrect in this analysis, and if any automotive specialists would like to comment, be assured I will try not to damage your reputation as I did inadvertently to D.L.

Now, regarding the other questions...well, I dunno. At least that's my story, as it leaves my age unknown and reputation intact!

SSB FM

The question of whether single sideband FM is a technical possibility was recently asked, and a contributor has since sent me a most interesting article on the subject. The article, by Richard Slater was printed in the publication called *HR* (Ham Radio), in January 1977.

According to Slater, the first patent for SSB FM was issued in September 1962 to K.H. Powers from RCA, coinciding with results described by E. Bedrosian in the November 1962 edition of *Proceedings of the IRE*. This makes it unclear who invented the system, although others have since worked in the field. However, it seems to have died a natural death, as nothing much else has appeared on the subject since 1971.

There are numerous technical problems, including the design of a suitable receiver, but the unanswered question is one of bandwidth. It may seem that removing either the lower or upper sidebands will give a bandwidth requirement half that of a conventional FM signal. But according to some researchers, the bandwidth of SSB FM will be *wider* than normal FM if the modulation index exceeds three, although others suggest this only applies to narrow band SSB FM.

The other interesting point made by Slater is that an SSB FM signal needs to have both frequency and *amplitude* modulation, similar to an AM SSB signal.

So SSB FM is possible, although as Slater points out, it is an impracticable means of transmitting high fidelity sound. Rather, he suggests that amateurs should examine *narrow band* SSB FM, as a conventional receiver can be used to detect it, with improved signal to noise ratio once the detection threshold is reached.

Video converter

The following letter seeks advice on the complex issue of VGA (for IBM computers) and whether the TTL-Analog converter described in February 1989 can be used to drive an RGB projector:

I need to interface an IBM computer to a Sony video projector. It seems that the TTL-analog video converter presented in February 1989 will do the job if the RGB outputs are cranked down. The projector has RGB, sync and a separate composite video input. The video card I am using is capable of emulating CGA, EGA, VGA and MGA in software, although for best resolution, it is preferable to use either CGA or VGA.

Can you tell me if this project is suitable for my needs and in particular could I use the VGA output with this project? (M.C., Parkerville WA).

The IBM computer video standards are as complex as the innards of the computer itself. In the article describing the TTL-analog converter, I discussed the topic of CGA and EGA, deciding to leave VGA and Hercules (MGA or MDA) unmentioned as the VGA standard is not compatible with the interface, and Hercules is monochrome.

From what I can figure out from the limited information I have on the topic, the VGA standard uses three signals, red, blue and green, in which each signal has up to 64 levels. In other words, it is really an analog signal, similar to the standard used by Apple. Also, the horizontal frequency is 31.468kHz, which is twice the rate of CGA. The vertical frequency can also be either 60Hz or 70Hz.

You mention that CGA is preferable, as it has 'best resolution'. In fact, CGA has the worst resolution of all, but because it uses standard horizontal and vertical sync rates, it may be your only choice anyway. I would think that the scan rates for the video projector are the usual 15,750Hz and either 50Hz or 60Hz, making EGA and Hercules incompatible.

So the interface driven with a CGA signal should be able to operate the projector, while VGA is definitely not suitable.

NOTES & ERRATA

Tester for Phone Answering Machines (May 1990): In the circuit schematic on page 97, the stepup transformer used to produce the ringing voltage should be labelled 'M2851'. It is referred to correctly in both the text and the parts list.

Headlights and Parkers Alarm (ETI, July 1990): Series resistor R2 should have a power rating of at least 2 watts, as it will typically dissipate about 1.6W when the motor is running. For highest reliability a 5W unit is recommended.

Low Cost Crystal Frequency Calibrator (March 1990): IC4 is a 4518 device, as indicated on the PCB overlay and in the parts list. The circuit schematic incorrectly shows it as a 4815.

What??

The question this month was supplied by Mr Don Law, (a great source of teaser questions) who derived it from a time-distance problem posed by a homework question given to students at the local high school. The question, which may seem impossible at first glance, is shown in Fig.2.

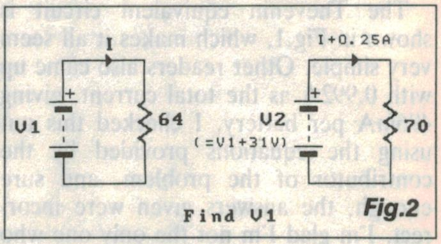


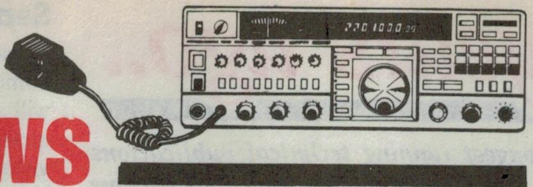
Fig.2

The problem is to find the value of V1, given that V2 = V1 + 31 volts, and the current in the second circuit equals I + 0.25A. The supplied answer was securely stapled together, with the challenge of 'no peeking'. I didn't, (truly) and I pass the challenge over to you. Yes, of course(?) I got the right answer!

Answer to last month's What??

The answer to last month's What?? is 10M. You see, it doesn't matter a hoot what the meter is reading, (that's the 'red herring'), as the resistance of a voltmeter doesn't vary unless the range is changed. To calculate the resistance of the voltmeter, that is, meter movement plus series multiplier resistor, simply divide the full scale deflection (FSD) voltage by the FSD current. In this case it was 100V divided by 10uA, giving 10M.

Amateur Radio News



Shanghai visit by IARC's Sam Voron

In response to an invitation from the Shanghai Children's Palace Amateur Radio Station BY4ALC, Sam Voron VK2BVS recently made a 14-day visit to Shanghai, PRC on behalf of the International Amateur Radio Club. The Shanghai Children's Palace (SCP) was set up in 1953, to provide a centre for after-school education and amateur club activities.

During the visit Mr Voron toured the SCP, met members of its amateur radio station and presented a lecture to 200 regional disaster co-ordinators, on how amateur radio volunteers provide disaster communications worldwide. He also gave lectures at the SCP to 50 teachers of amateur radio, about the formation of local, national and international communications networks for disaster assistance, and to around 300 students on the role of amateur radio volunteers during disasters.

In addition Mr Voron presented the SCP with a portable 'Atlas' battery-operated HF transceiver for emergency use, and provided technical assistance by repairing transceivers at BY4ALC, at the Shanghai Radio Sport Association's station BY4AA, at BY4AOM (a station for amateur volunteers aged 70 or more), and at BY4SZ, the Szu Zhou Radio Sport Association located about 100km north of Shanghai.

WIA Bandplans available

A 38-page booklet has been published by the WIA, giving detailed bandplans for all Australian amateur service bands from 1.8MHz to 47GHz, together with an explanation of band planning and bandplan presentation. Cost of this new and handy publication is $2.80, including handling and postage, and it's only available from the WIA's Executive office. Remittances, made out to 'WIA', should be sent to Bandplans, PO Box 300, Caulfield South, 3162.

Apparently only a limited number were printed, however, so you may have to be quick in order to get one.

To allow amateurs to keep their booklet up to date as a reference, the WIA intends to issue update pages from time to time as required, for a small fee.

US amateur magazine closes

After over 20 years of publication, the US magazine *Ham Radio* has closed down. The final issue published was that for June 1990.

The magazine and its 'Ham Radio Bookstore' were sold to the publisher of *CQ* magazine, and existing subscriptions to *Ham Radio* are being fulfilled by that magazine.

Active on 1296MHz or higher?

The WIA's WARC 92 Australian Preparatory Group representatives are compiling information on the use of the microwave bands (1296MHz and above), and are keen to hear from amateurs working on these bands.

If you are active on these bands, please advise details to John Martin VK3ZJC, Chairman of FeTAC, at the WIA's Executive office, c/o PO Box 300, Caulfield South, 3162. A precis of the data collected will be published in *Amateur Radio*, when it has been collated.

RADIO CLUBS – NEED PUBLICITY?

Australia has quite a few active radio clubs and societies, but many are well-kept secrets – perhaps due to lack of funds for publicising their activities. *Electronics Australia* is happy to help radio clubs and societies by publishing news of their activities in this column, free of charge. Simply send details to Jim Rowe, Managing Editor Electronics Australia, PO Box 227, Waterloo 2017.

50 and 25 years ago..

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Below we feature some items from past issues.

September 1940

6K7-GT released: The 6K7-GT is a new valve which merits special attention. It is electrically similar to type 6K7-G except that the mutual conductance has been increased to 1600 micromhos under typical conditions (being in this respect similar to type 6U7-G) and that a slight modification has been made to the structure. In the 6K7-GT the internal screens are returned to the suppressor pin instead of to the cathode pin as in the 6K7-G. This change has been made in order to make the 6K7-GT more adaptable for special circuit requirements.

The 6K7-GT is particularly suitable for use in automobile or midget receivers and equally suitable for use in large receivers and may replace the 6U7-G.

Interesting actuality broadcasts: The most noticeable change in reception during the past month has been the gradual strengthening of the European stations on the 16 and 19 metre bands at night. From now on this improvement should be maintained, and before long we can expect excellent results from all the well-known stations on these bands, and possibly some new ones in addition.

Both from England, and also the USA, we have heard some very interesting broadcasts, perhaps the most appreciated being a description of some of the air raids on England, which brought home to listeners in this country how thankful they should be they have been spared this horror of modern warfare.

September 1965

Home video recorder: A new line of home videotape recording systems that will make immediately-playable high quality recordings of live action or television broadcasts for home viewing, was introduced recently by Ampex Corporation.

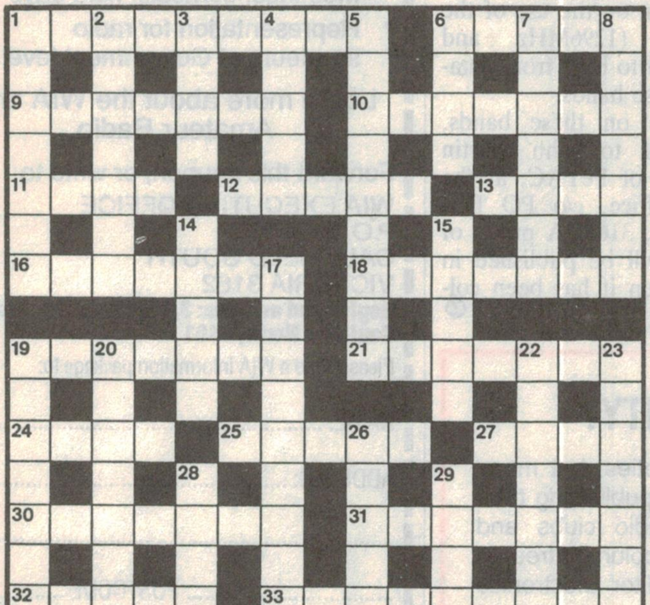
The new Ampex line is built around a compact video-tape recorder, which retails at $1095 in a one speed table-top model, $1295 for a two speed model. Four furniture console systems, including the recorder, television camera, television receiver and related accessories range in price from $1795 to $2495 depending on choice of one-speed or two-speed recorders and colour or black and white receivers.

The videotape recorder is approximately the size of a conventional large audio tape recorder. One-inch-wide magnetic tape moves past rotary recording and playback heads at a speed of 9.6 inches per second (ips) to provide high frequency performance with relatively low tape consumption. A second speed of 4.8 ips will also be offered, cutting tape consumption in half and providing good quality recordings not compatible with colour.

EA CROSSWORD

Across

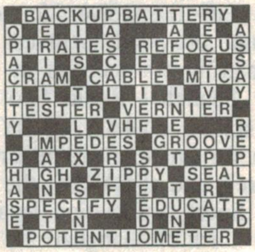
1. Founder of the quantum theory. (3,6)
6. Remains fixed on a set frequency. (5)
9. Protected against interference. (7)
10. Unwanted effects in DC. (7)
11. Revise and correct recorded data. (4)
12. Greek letter. (5)
13. Recording medium. (4)
16. Transmitted data. (7)
18. Power points, or 240W ---- (7)
19. Metal forming a compound used as a semiconductor. (7)
21. Laser emissions from a navigational beacon. (7)
24. After a delay. (4)
25. Set at a particular potential. (5)
27. Reference point for a satellite. (4)
30. Electrical appliance, the --- fan. (7)
31. Amount by which a quantity falls short. (7)
32. Sir Oliver ----, pioneer of the coherer. (5)
33. Adventurous entrepreneur whose name is renowned in retail electronics. (4,5)



Down

1. Alloys with permanent fields. (7)
2. Utilising radiation in the higher frequencies. (1-6)
3. This may be found with a metal detector. (4)
4. Concerned with part of a stationary wave. (5)
5. His laws are used in circuit theory. (9)
6. Where modern microcomputers may be found. (4)
7. Sort, as do certain photocopiers. (7)
8. Groups of connected devices. (7)
14. Facility in a house alarm system. (5)
15. Energy medium between coal and electricity. (5)
17. Represented artificially. (9)
19. Non-spillable energy source. (3,4)
20. Maintained state of a circuit. (7)
22. Japanese electronics company. (7)
23. Fault on vinyl disc. (7)
26. Underwater detection system. (5)
28. Safety device in circuit. (4)
29. Electronic transfer of funds. (pl.) (4)

SOLUTION TO AUGUST



EA with ETI marketplace

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Silicon Valley NEWSLETTER

Analog Devices, PMI merging

Two of the industry's largest producers of analog-based semiconductors have announced a merger. Precision Monolithic, owned by the Bourns group, said it has agreed to an S$80 million cash offer from Analog Devices.

For Precision Monolithic, better known as PMI, the acquisition will mark one of the few major events in the company's 21-year history. As scores of digital-based chip makers around it quickly grew into mammoth businesses, PMI's sales have grown at a much slower pace, reaching just US$88 million in 1989.

Whereas PMI specialises in products that amplify electronic signals, Analog Devices of Norwood, Massachusetts, is best known for converting analog information into a digital format computers and other electronic devices can read and process. The company had 1989 sales of US$458 million.

The acquisition will be subject to the approval of both boards of directors and the Justice Department's antitrust division.

Sony, Matsushita to buy more US chips

Sony and Matsushita, two of Japan's largest electronics manufacturers, as well as Nissan Motor, have announced they will increase their purchases of US-made semiconductors in an effort to help reduce trade friction between the US and Japan over the lack of progress in Japanese market access for American chip makers.

Meanwhile, in accordance with a recently reached trade agreement on supercomputers, the Ministry of International Trade & Industry also announced a set of guidelines for federal agencies and educational institutions aimed at increasing the purchases of American-made supercomputers.

As part of the new guidelines, agencies and universities may no longer require huge discounts from the manufacturer, a factor that has effectively shut out Cray Research and other companies from bidding on Japanese federal and university contracts.

IDT is a quiet Santa Clara-based semiconductor maker, which has just built a US$60 state of the art plant in San Jose. Chairman and CEO is John Carey, an Englishman who was one of the founders of AMD.

Sony and Matsushita said they will increase their purchases of foreign chips from the current levels of 14% and 13% respectively, to 20% by the end of this year.

"We are making an earnest effort by setting the 20% target," a Sony official said. He added that the company will work with foreign chip makers to incorporate their products at the design stage of new products, ensuring them volume sales when those products are released.

Sony currently uses almost 2500 new chip designs a year, 400 of which come from non-Japanese chip makers. That will increase to around 600 chips under the new plan.

Motorola launches multi-media processor

Trying to establish itself as the leading supplier of processors for the coming generation of multi-media computers, Motorola has introduced the 96002, to be known as the 'Media Engine,' a super fast processor capable of simultaneously processing data, sound, video and graphics signals.

The chip, which has been more than two years in the making, is a next-generation extension of the company's 32-bit floating point processor family and is based on the same architectural structure as the original 24-bit 56001 FP chip.

"Our technology calls for two symmetrical arms that allow data to move on the right side and on the left side of the chip while processing is going on within the chip," said a Motorola spokesman for the Microprocessor Products Group. Essentially, the 96002 is designed as an attached processor, supplementing central processing units, he said.

In terms of performance, the 96002 will be marketed as Motorola's answer to Intel's i860 RISC processors and will operate in the same 40-80MIPS performance range.

For now, Motorola will be battling a slightly uphill battle, analysts say, because Intel has had a one-year lead over Motorola in this area and has locked up a substantial number of customers in this still somewhat limited field of vendors. But Motorola believes it will be able to catch up fast as a number of customers who have been evaluating the 96002 will introduce products around the chip before the end of this year.

The price of the 96002 will be $750 in sample quantities, with substantial dis-

counts available when vendors start ordering in production quantity.

Data highway planned for US

Following its initial announcement last September, the US National Science Foundation formally revealed its plans for building a nationwide highspeed data network that will be able to handle data at speeds of more than 700 times the current rate.

The US program follows similar efforts at building highspeed data highways already underway in Japan.

When completed, researchers will be able to send data back and forth at the rate of more than 150 good size novels every second. Current technology allows for only about one such novel every four seconds, far too slow for effective computer-to-computer communciations.

The first phase of the program will be financed with US$15 million worth of grants from the NSF and DARPA, the Pentagon's advanced technology development agency.

In addition, companies including IBM, AT&T and MCI have signed on to provide another US$100 million towards the completion of the three year project. Besides these and numerous other major corporations, leading universities such as MIT, Stanford, as well as five national supercomputer centres and national laboratories at Livermore and Los Alamos will participate in the building of the data network.

The network will be based on fibreoptic cables. The vast amount of data that can be transmitted over such lines will allow for the simultaneous transmission of both video and data, or its hybrid, advanced computer simulation. Researchers in one lab could access high-quality computer simulation data from a remote supercomputer and manipulate the data on-line almost as if the machine were sitting in the next room.

Bush launches Mars program

Launching what may become man's greatest technological challenge yet, President Bush has announced that the United States will undertake a space program aimed at putting a man on Mars before the year 2020.

"I believe that before the 50th anniversay of its landing on the moon, the American flag should be planted on Mars," Bush said, adding that like the way the Apollo program forever changed the world, the Mars project would again change history.

Bush's 30-year time table may seem long compared to the seven year deadline President Kennedy gave NASA in 1961 for putting a man on the moon. The Mars project however, is infinitely more complex. Early estimates put the cost of such an adventure well over US$200 billion over the next 30 years, climaxing in a dangerous mission that could take as long as three years.

Some of the technological challenges NASA will be facing include:

- Travel time: With current technology, it would take as much as three years for a round-trip voyage. New spacecraft engines, possibly nuclear-based, will have to be developed that can dramatically cut the travel time, preferably to only a few months for a one-way trip.
- Zero gravity: Perhaps the greatest concern of the entire mission is developing techniques that will lessen the serious, if not fatal, effects of prolonged exposure to weightlessness on bones and muscles. Loss of bone mass could amount to as much as 30% during a two-year mission. Besides leaving the spinal cord and leg bones dangerously fragile, the lack of calcium could cause kidney stones to develop. NASA scientists also believe immune deficiencies develop more easily in zero gravity environments.
- Space manufacturing: A mars spacecraft would have to be built in space, probably at the orbiting space station which will be in full operation by then. It would be too large and bulky to be launchable from Earth.
- New materials: Industry will be pushed to develop materials that are even lighter and stronger than the current generation of composites.

NASA however, believes the mission to Mars will provide the technology and means for commercial exploration of the nearby universe, including the mining of valuable minerals such as cobalt and platinum in the asteroid belt between Mars and Jupiter.

Bill Gates' mega-mansion

How big is big enough, when it comes to one's home? When it comes to a whiz kid with a billion dollars in the bank, VERY BIG!

Microsoft chairman Bill Gates has decided to put some of his money into a new dream home that measures a scant 45,800 square feet, or 5100 square metres – almost 1.5 soccer fields worth of floor space!

Surely that is BIG, considering that the average mansion put up around Silicon Valley by its many millionaires usually measures 4500 to 5500 square feet.

The main house of the estate will have some 35,800 square feet, all of it to be built into a steep hillside with a splendid view of the Seattle area. The other 10,000 square feet will be used to build an underground garage big enough to store 20 cars, a caretaker's house and a lakeside pavilion.

Cost of the project is estimated between US$5-10 million. While that may still seem like small change for Gates, wait until his wife gets to decorate all of those 46,800 square feet!

Of course, the house will have lots of 'Windows'...

Pentagon report calls for HDTV research

The struggle between pro- and anti industry support groups within the Bush Administration continues with a Pentagon task force recommending that the US spend at least US$100 million a year on the development of HDTV-related technologies.

The report came just weeks after the Pentagon removed and demoted the director of its DARPA technology research group, who had been a strong supporter of HDTV and other technologies with both military and commercial applications.

The 'High-Resolutions Task Force' made its recommendation to the Defense Science Board, for its quarterly meeting. The board reports directly to Defense Secretary Dick Cheney.

The task force was set up to investigate the military application possibilities of future high-resolution displays in radar and other military areas. Recently, however, DARPA and other research arms of the Pentagon have run into strong opposition from the White House on the sponsoring of so-called 'dual-use' technology development projects, where technology could be used in both military and commercial applications. That conern apparently was strong enough to force the removal of DARPA director, Craig Fields, an outspoken supporter of such projects.

Political observers speculate the Pentagon will probably ignore the recommendations of its task force.

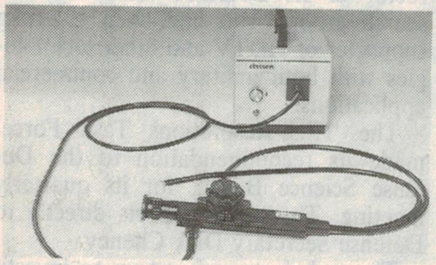
NEW PRODUCTS

Low power miniature relay

Due to its advantageously formed magnetic circuit, the P1 miniature relay (MRP1) from Siemens can be operated with particularly low energising power – in spite of high contact forces. The monostable version has a rated power of only about 65mW, while about 30mW is required for the bistable design. As an extension to the range, a high-sensitivity monostable version with a rated power of about 34mW has been designed for special applications. All relays are designed for surface mounting.

The MRP1 meets all the demands placed on a modern light-current relay: its small size (0.68cc) allows a high packing density while the high sensitivity results in low self heating. The relay is washable, including ultrasonic washing, it is also UL and CSA listed, as well as flameproof to IEC 695. The actuation times are extremely short.

For further information contact Siemens Components, 544 Church Street, Richmond 3121 or phone (03) 420 7308.



Endoscope for inaccessible spots

The Machida FB10/1500A endoscope has been designed to enable inspection of the inside of tubes, pipes, boilers, engines and other inaccessible spots. It is 1500mm long, 10mm in diameter and uses fibre optics technology.

The endoscope is fully flexible and provides a magnified view, in normal colour, of the area under observation. The viewing angle if 45° forward and the tip of the endoscope can be moved up and down and side to side by approximately 100°. All adjustable controls are grouped together, for ease of use, in close proximity of the eyepiece.

Light is carried to the tip of the probe by a flexible light guide 2m long. The subject can be viewed under ambient light conditions or by using any suitable external source. Depth of focus is from 7mm to infinity and is fully adjustable.

For further information contact your nearest Tech-rentals office, or phone (03) 879 2266.

Large LED displays

Australian instrument maker AIC has released a large (127mm high digits) display unit for applications that require wide range viewing. The unit can be supplied to measure weight, temperature, speed (RPM), pressure, humidity, current (4 to 20mA) and many other industrial parameters. Typical applications include weighbridges, foundries and factories.

The display features large high brightness LED displays and an integral filter, thereby ensuring good visibility, even in areas with high ambient light levels. Installation is simplified, since the instrument is supplied with a pre-drilled backing plate.

Since the display is controlled by an external AIC instrument, functions such as alarm relays, recorder and RS232/RS485 outputs can be applied to the measured units.

For further information contact Amalgamated Instrument Co, 7/21 Tepko Road, Terrey Hills 2084 or phone (02) 450 1744.

Broadband frequency counters

The XL microwave frequency counters have a measurement range of 10Hz to 3GHz to the model 3030, 10Hz to 8GHz for the model 3080, 10Hz to 12.4GHz for the model 3120 and 10Hz to 20GHz for the model 3200.

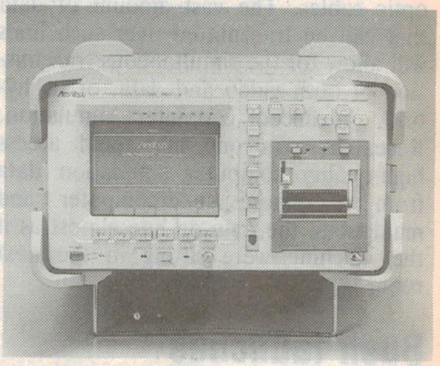
Signals in the frequency range of 10Hz to 120MHz are measured by the direct count method (with signals below 10kHz, reciprocal counting techniques are used). Signals in the frequency range of 120MHz to 20GHz are down converted to an intermediate frequency (IF) by a harmonic heterodyne down-conversion technique. The counted IF is added to, or subtracted from, a multiple of the local oscillator (LO) frequency to determine the input frequency.

For those who have a need for a counter above 20GHz, the model 3260 offers an extended operating upper limit of 26.5GHz.

Another new product, the 3201 source locking microwave counter provides the facility to lock the counter to any source frequency between 10MHz and 20GHz with an accuracy of 1Hz.

All XL microwave frequency counters feature a built-in RF power meter that enables the user to measure RF signal levels over the entire range of the counter.

For further information contact ACL Special Instruments, 499 St.Kilda Road, Melbourne 3004 or phone (03) 820 3044.



Data transmission analyser

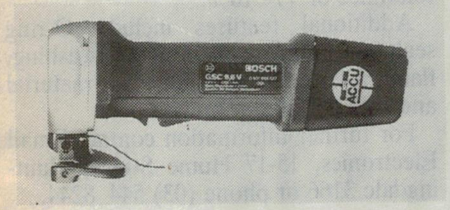
Anritsu has released a new data transmission analyser, model MD6420A, covering the range 50bps to 10Mbps. The unit comprises a main frame with plug-in and extension units, for various interfaces for evaluation of data line quality.

The MD6420A is compact and port-

able and is capable of many functions including error analysis and clock slip detection. Data will not be lost if a power failure occurs during measurement. Measurement data can be stored in the unit and the results later displayed as a histogram.

Measurement settings and values as well as the error and alarm conditions can also be printed out along with measurement times via a built-in printer. Up to 22 different measurement items can be displayed on a single screen.

For further information contact Alcatel STC, 58 Queensbridge Street, South Melbourne 3205 or phone (03) 615 6666.



Cordless metal shear

The new GSC 9.6V cordless shear is said to have the traditional qualities of Bosch electric shears – such as continuous operation through robust gearing, cutting on curves and cutting visibility – and added the convenience of battery power.

With a 'no load' stroke rate of 4000/-min, the new 9.6 volt GSC 9.6V can cut up to 155m in 0.5mm steel sheet, 40m in 1.2mm, steel sheet and 105m in 0.5mm steel sheet before requiring re-charging. It can also cut aluminium up to 1.5mm thick.

Cutting blades can be quickly set with the assistance of the setting gauge to suite the material being cut. Blades are easily sharpened.

The GSC 9.6V, which weighs just 1.5kg, is fitted with a swarf protector to keep swarf clear of the operator's hands.

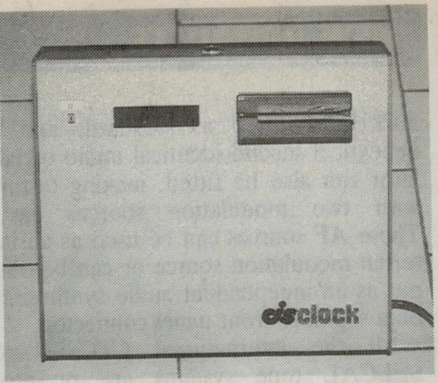
The new shear is supplied ready to go with a battery quick charger, key and blade set.

For further information contact Robert Bosch (Australia), Cnr Centre & McNaughton Roads, Clayton 3168 or phone (03) 541 5555.

Computerised time card system

Cisclock is a data acquisition system specially designed to provide a vital link for a company's computerised payroll system.

With the identification barcoded or in



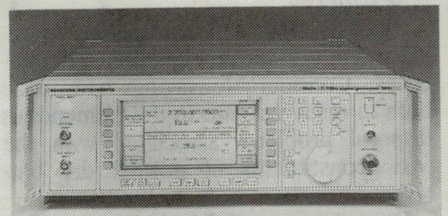
the form of magnetic strip on ID card, Cisclock captures essential time and attendance information of each employee to compute salary.

With slim packaging (270 x 322 x 114mm), it can be mounted easily to any remote location of up to 1.2km in a multidrop and/or point to point configuration. As many as 30 Cisclocks can be connected on the same party line directly linking to the computer.

Cisclock supports the industry standard ISO magnetic and barcode card types. It also allows up to 30 pre-programmed alarm settings to indicate shift change over meal and tea break, etc.

Cisclock interfaces with a wide range of computer systems from personal to mainframes.

For further information contact Zitech Electronics, 57 St. Hellier Street, Heidelberg Heights 3081 or phone (03) 459 7222.



Signal generators with LCD display

Marconi Instruments' new family of signal generators, the 2030 series features a large and innovative backlit LCD instead of the usual rows of LEDs. There are currently two models in the range; the 2030, covering a range from 10kHz to 1.35GHz, –138dBm to +13dBm, and the 2031 covering a range from 10kHz to 2.7GHz with output from –144.5dBm.

Both units feature 0.1Hz resolution at all frequencies using Marconi's patented 'fractional n' synthesis technique. A completely variable high quality audio oscillator covering a range of 0.1Hz to

500kHz is fitted as standard, and if needed, a second identical audio oscialator can also be fitted, making testing with two modulation sources easy. These AF sources can be used as an internal modulation source or can be output as an independent audio synthesiser on a separate front panel connector.

All the international CTCSS and SELCAL tone systems are pre-programmed into the instrument, saving hours of set-up time and further enhancing the ease of use. For the new generation of digital radios a stable DCFM mode is included. For users with high data rates, a wide band FM mode is available, offering a 10MHz bandwidth.

GPIB to the latest IEE 488.2 is supplied as standard.

For further information contact Marconi Instruments, 15 Orion Road, Lane Cove 2066 or phone (02) 418 6044.

Environment friendly torches

The Nitech range of rechargeable torches has been designated 'environmentally sound'.

Under the 'UK Better Environment Awards for Industry', Nitech received an award for the development of the patented 'X-cell rechargeable lantern-type battery'.

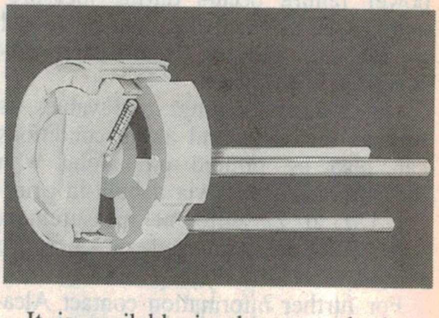
Each X-cell has been equated to replace 2.5 tons of conventional dry batteries. Considerable savings are made both in resources and in the tremendous disposal problems associated with the toxic constituents of normal dry batteries.

Other features of the Nitech rechargeable hand lamp, which gives eight hours of continuous non-fade light, includes a patented lens system with a halogen bulb offering 10 times the life of a normal bulb, and a rugged waterproof polyethylene case.

For further information contact Ostaline, 4/5 Lyn Parade, Hoxton Park 2171 or phone (02) 607 9099.

High reliability cermet trimmer

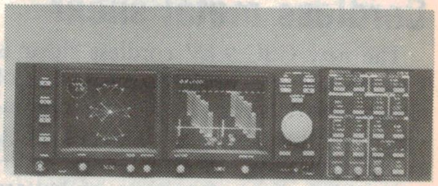
The model 75, 6mm single turn cermet trimmer from Spectrol Reliance is aimed at high reliability applications. It has been tested to environmental and performance requirements of Mil Std 202 and Mil R22097.



It is available in three standard pin styles for top or side adjust and a resistance range from 10 ohms to 20M with tolerance of +/- 10%.

Additional features include O-ring seal for solvent and aqueous washing, flame retardant rotor and body material and solder plated terminals.

For further information contact Email Electronics, 15-17 Hume Street, Huntingdale 3166 or phone (03) 544 8244.



Video measurement set

Tektronix's premier 1781R video measurement set is a multifunction, wide bandwidth, multi-input analog video measurement set.

The touch screen lets an operator make selections quickly without going through many menus. Its programmed measurement modes allow accurate measurement of differential gain and phase.

If a measurement is made in the presence of noise, the digital recursive filter minimises the effect of the noise, making the display more readable. Voltage and timing cursors ensure precise amplitude and timing measurement even when the signal is fully magnified. Measurement results can be displayed numerically to 0.1%, 0.1°, or 1mV. Its picture display mode permits positive identification of video signals.

Other features include full line select, polar SCH phase display, semiautomatic setups and tangential noise measurement.

For further information contact Tektronix Australia, 80 Waterloo Road, North Ryde 2113 or phone (02) 888 7066.

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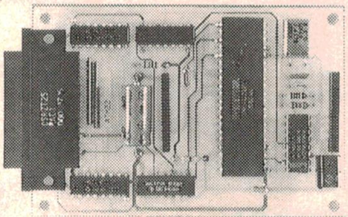
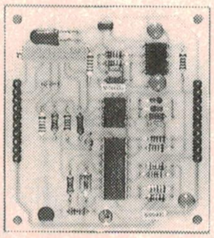
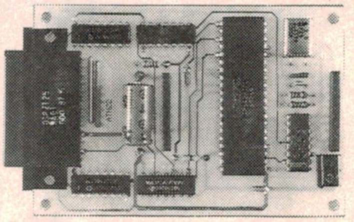


16 CHANNEL REMOTE CONTROL (TX)
ATM22 is a 16 Bit parallel to serial converter encoding 16 static or changing inputs to a serial data stream at 5 frames/Sec.
ATM22 $64.50

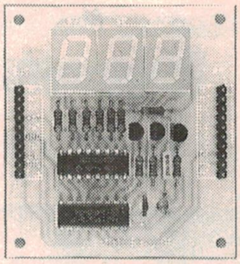


TRANSCEIVER
ATM24 clip-on Application PCB for 22&23, twisted pair + opto coupled current loop.
ATM24 $29.00

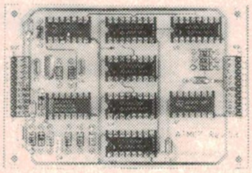


16 CHANNEL REMOTE CONTROL (RX)
Companion receiver, serial to parallel decoder. 16 outputs, useful as switchboard repeater etc. Range to 4Km with ATM24
ATM23 $64.50

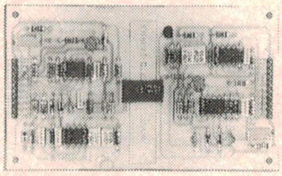
RADIO MODEM
Clips onto 22 & 23 to provide V23 simplex communication via CB, 2 Way etc. for data acquisition, remote control etc. Connects to Mic. & Speaker output.



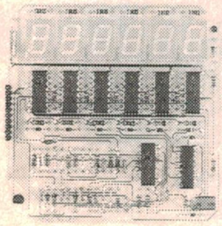
ATM25 $55.50



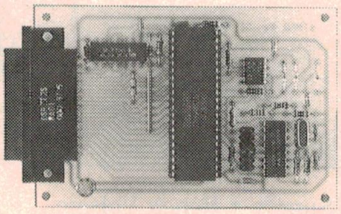
10MHz TIMEBASE
Xtal controlled Osc./Divider 10MHz to 1Hz in decades.
ATM07 $42.00



10KV ANALOGUE ISOLATOR
Precision 0.05% V/F/V. 1V in, 5V out 12V @ 10mA each side, 10KV coupler.
ATM16 $59.00

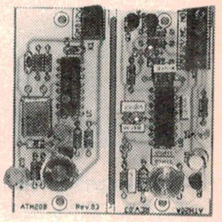


6 DIGIT BATCH COUNTER
Preset from 1 to 999999, counts from input clock down to "0", stops clock & turns off relay driver. On board 500mA 50V relay driver transistor. For Batch Counting
ATM12 $62.50



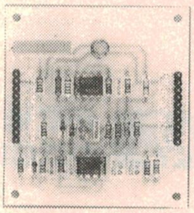
8 BIT UART
Parallel/serial/parallel TX & RX, 6 Baud rates, RS232 I/O.
ATM18 $55.00

IR BARRIER
Break apart TX/RX for security etc. range to 15 Metres, NO/NC outputs 12V @ 30mA. Noise & sunlight immune simple alignment, no lenses. For security etc. Includes 2 mounting cases

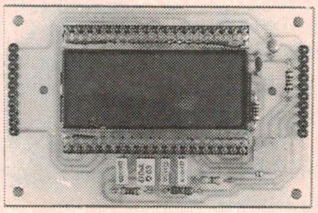


ATM20 $48.50

PRECISION V/F CONVERTER
Input 0 to 1V, output 2KHz to 7KHz 0.03% accuracy. Zin 500K open collector output, single +12V supply @10mA. Compensated against temp. & supply drift. Interfaces directly to ATM09 for complete data conversion link.

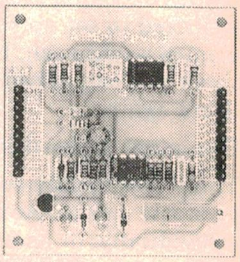


ATM08 $35.50



LCD VOLTMETER
3 1/2 Digit Hi contrast, ±199.9 mV sens. 9V supply @ 1mA, Zin 100MΩ
ATM14 $38.50

PRECISION F/V CONVERTER
Input 2KHz to 7KHz output 0 to 5V ±0.03% accurate, single 12V supply @ 10mA. Matched to ATM08 for noise immune V/F/V conversion via opto couplers or data communication via radio, telemetry, modem or fibre optic link.



ATM09 $35.50

by PETER LANKSHEAR

Report on the NZVRS 'Conference 90'

Vintage radio societies are thriving, with Australia and New Zealand each having a major club. The New Zealand Vintage Radio Society, the senior of the two, is now 10 years old. During 1990, New Zealand is recognising its sesqui-centennial in many ways, with clubs and societies being encouraged to hold celebrations. Accordingly the NZVRS, with perhaps a little trepidation, arranged a convention for the holiday weekend of 2nd June.

With something like 50% of the 250 or so NZVRS members living in the greater Auckland area, there was no question as to where the convention should be held. Planning commenced at the start of the year, and to the considerable credit of all involved, the whole complex event went like clockwork.

The convention programme format was based on that evolved by America's veteran Antique Wireless Association, which has for many years conducted successful conventions. It proved to be a winner here also. After registration formalities, the Saturday morning was given over to addresses. The afternoon was taken up by an auction and the convention dinner filled in the evening. Sunday was spent by groups visiting a range of Auckland collections.

HRSA represented

An honoured guest was Ray Kelly, editor of the Historic Radio Society of Australia's *Bulletin*. First to give a formal address, Ray described the history of the eight year old Australian Society, which has a membership about 50% greater than its trans-Tasman counterpart.

Then followed a talk by fellow Australian John Mann, who related in a most entertaining manner the trials, tribulations and successes in a hobby combining two popular fields of preservation, the restoration of vintage car radios.

Final event for the Saturday morning was an outline by your scribe of the history of the superheterodyne receiver.

The auction

Auctions are always popular events at vintage radio society functions, and the NZVRS effort on June 2 was no exception. This is understandable, as auctions perform several functions. They provide an opportunity for some members to cull their collections, and for others to add to theirs.

Fig.2: A corner of the pioneer New Zealand collection belonging to John Stokes.

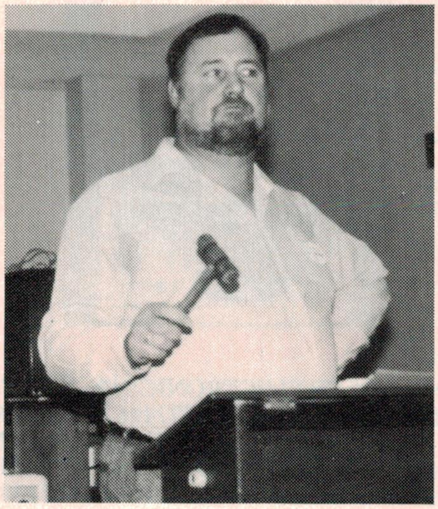


Fig.1: A small Philco curved-end mantle goes under Don Strange's hammer at the NZVRS Conference auction.

Another important aspect of auctions is providing an idea of the value of radios. Unlike some hobbies, vintage radio has no recognised standard set of values. Transactions conducted in isolation tend to be 'one off' and frequently result in bartering or swapping. Collectors can gain from an auction an indication of the worth of equipment, while the club benefits considerably from the 10% commission on sales.

The group of 120 or so items of equipment to go under the NZVRS hammer was impressive. Ranging from the 1920's to the cutoff date of 1960, there were horn speakers, plastic radios, metal boxes, handsome consoles, novelty receivers, books, crystal sets, test instruments and several excellent repro-

ductions of early home built receivers. Most common were mantle radios from the 1950 period.

Prices were as varied as the lineup, and there was something for everybody. Society President Don Strange displayed his auctioneering skills in keeping the action going and the bidders on their toes. The top bid of $410 was by a South Island enthusiast for an excellent 1928 Atwater Kent model 40 metal box receiver, without speaker. At the other end of the scale, average quality small plastic mantle receivers from the middle 1950's fetched less then $20.

A surprise to some was the popularity of a group of finely crafted replica receivers of the 1920's. A one-valve boy's radio in a mahogany cabinet fetched $120 and a three-valve regenerative receiver reached $290. Radios of this type have a special place in collections. Home building from scratch and kitsets was an important aspect of early radio, and it can be argued that provided genuine parts and technology are used, the actual assembly date is not important.

The auction placed a premium on receivers being in operating condition, if only to assure purchasers that essential components, in particular power transformers, were intact.

Final event for the day was the Conference dinner. An excellent meal was accompanied by much animated conversation, well into the evening.

A popular feature was the display in the convention room of a wide range of choice vintage and novelty receivers, selected from members' collections. Another display item to receive much attention was a flawless replica of a 1925 *QST*-designed one-valve Hartley transmitter.

Tour on day 2

The second day was given over to local members escorting groups of visitors around Auckland to see a selection of displays. Obviously, only a few collections could be included, but the half dozen or so chosen revealed just how wide the variation in interests can be, ranging from small to large, and from general 'run of the mill' receivers to superb landmark radios of the 1920's.

Fig.7: A beautifully presented Atwater Kent model 53 on display. This early all-mains powered receiver has a steel cabinet which doubles as a table.

Fig.4: Eric Kirby demonstrates his replica 1925 transmitter.

There were contrasts in ages of collectors. One young enthusiast who has been collecting for about six years, has an enviable assembly of carefully chosen classics that any collector would be proud to own. It is most encouraging to find that there are younger people committed to becoming responsible and knowledgeable custodians of the early equipment, which in time they are likely to inherit from the pioneer collectors.

Next we saw the work of a more senior citizen who in only four years has gathered together an incredible collection that at last count numbered 550 radios. Whilst most of his models are not particularly rare, nevertheless he has some classics, and his receivers form an invaluable collection that gathers in one place numerous examples of the everyday radios from the pre-TV period, when there was a valve receiver in practically every household.

Each collection selected had a different theme. One caught the eye with its attractive presentation. Sets varying from a classic Canadian Rogers mantle, with beautiful veneers, to groups of coloured plastic midgets were all tastefully arranged to create maximum visual impact.

Another popular venue was one of New Zealand's pioneer collections, which includes historic pre-1920 receivers and many fine early classics from New Zealand manufacturers.

Fig.3: Some worthwhile sets saved from the scrap heap. This is a small part of a collection totalling well over 500 receivers.

Fig.5: An international part of Fred Pond's carefully staged collection of immaculate receivers, this section featuring American, Australian and English models.

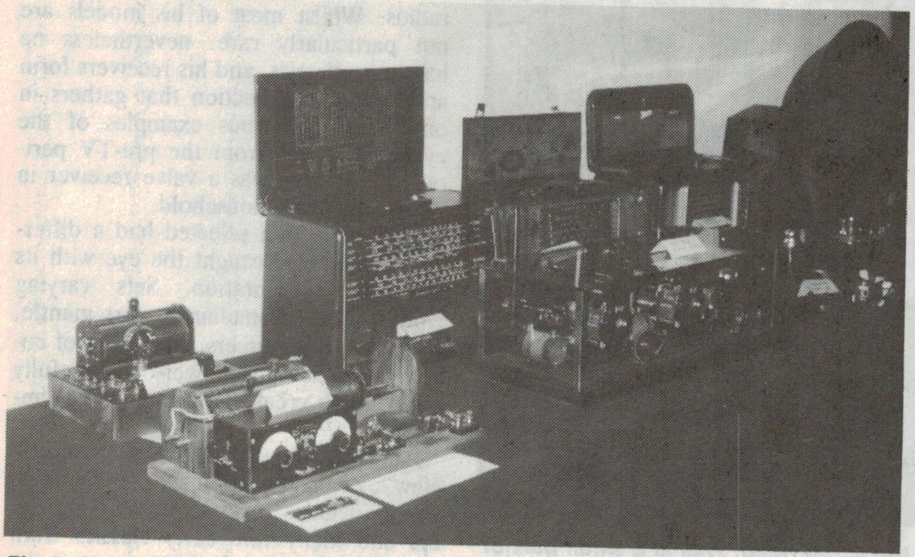


Fig.6: Some of the unusual receivers on show.

Valuable lessons

There could have been few who were not impressed and inspired by the convention and the displays. Most visitors would have returned home with plenty of ideas on how to improve their own displays. Some important aspects of serious collecting became apparent, and are worth passing on.

What appeals to one collector may be of little interest to another. This is predictable in a hobby as diverse and wide ranging as ours, and an active club with a large membership means that no aspect of vintage radio is neglected.

Both the auction and the members' displays reinforced the importance of caution in refinishing valuable equipment. It is very easy to degrade the historic and monetary value of a radio by thoughtless, inept or over-enthusiastic 'restoration'. There was agreement in discussion that rare and valuable cabinets needing attention should be professionally refinished with original stains, shading and lacquers, but it cannot be over emphasised that unless a classic radio is in really bad condition, careful cleaning only is the best policy.

Club membership

The convention confirmed the value of club membership. Although many members live in isolation, they are kept in touch with the vintage radio scene by the club newsletters and out of town visitors. A surprising number belong to both the HRSA and the NZVRS, and membership of one or both is strongly urged for collectors regardless of whether they have only one radio or a large collection.

The Historic Radio Society of Australia contact person is:

The Secretary, HRSA,
Rex Whales,
PO Box 283,
Mt Waverly, Vic 3149.

And his New Zealand counterpart can be contacted as follows:

The Secretary, NZVRS,
Bryan Marsh,
20 Rimu Road,
Mangere Bridge, Auckland.

Both organisations welcome new members and publish well edited bulletins quarterly.

The 1990 Vintage Radio convention is now over. But if many enthusiasts have their way, it will not be the last, with several expressing the hope that the HRSA could host the next in two year's time.

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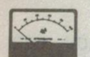
Current: 50, ±50, 100, ±100µAdc
1, ±1, 100mAdc
1, ±5, 10, 20, 30Adc
10, 20, 30Aac



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Model ST-45

Dimensions: 51x51mm
Scale: 51x31mm
Bolt centres: 38x38mm 3.5mm hole
Ranges:
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Current: 50, ±50, 100, ±100µAdc
1, ±1, 100mAdc
1, 5, ±5, 10, 20, 30Adc
10, 20, 30Aac

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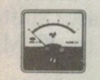
Model ST-65

Dimensions: 67x67mm
Scale: 66x38.5mm
Bolt centres: 51x51mm 3.5mm hole
Ranges:
Voltage: 10, 20, 30Vdc, 300Vac
Current: 50, ±50, 100, ±100µAdc
1, ±1, 100mAdc
1, 5, 10, 20, 30Adc
10, 20, 30Aac



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Scale: 44x25mm
Bolt centres: 31x31mm 3.5mm hole
Ranges:
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10Adc, 10Aac

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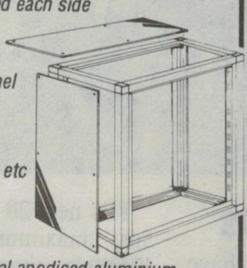

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Size	4RU	6RU	12RU	18RU	30RU	38RU
Height	280mm	370mm	630mm	900mm	1430mm	1790mm
Frame	H0362	H0365	H0368	H0370	H0375	H0380
Price	**$139.00**	**$149.00**	**$169.00**	**$189.00**	**$229.00**	**$269.00**
Panel	H0363	H0367	H0369	H0372	H0377	H0382
Price	**$49.00**	**$55.00**	**$89.00**	**$110.00**	**$159.00**	**$195.00**

Accessories	12 pack		100 pack	
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Rack Screws Black	H0390	**$2.95**	H0391	**$19.95**
Rack Captive Nuts	H0395	**$5.95**	H0396	**$45.50**
Nylon Washers	H0398	**$1.50**	H0399	**$ 8.50**

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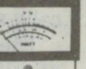

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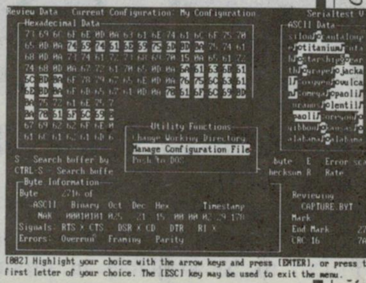

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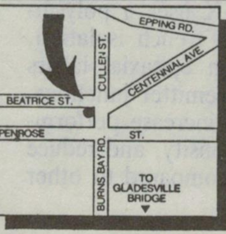

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Solid State Update

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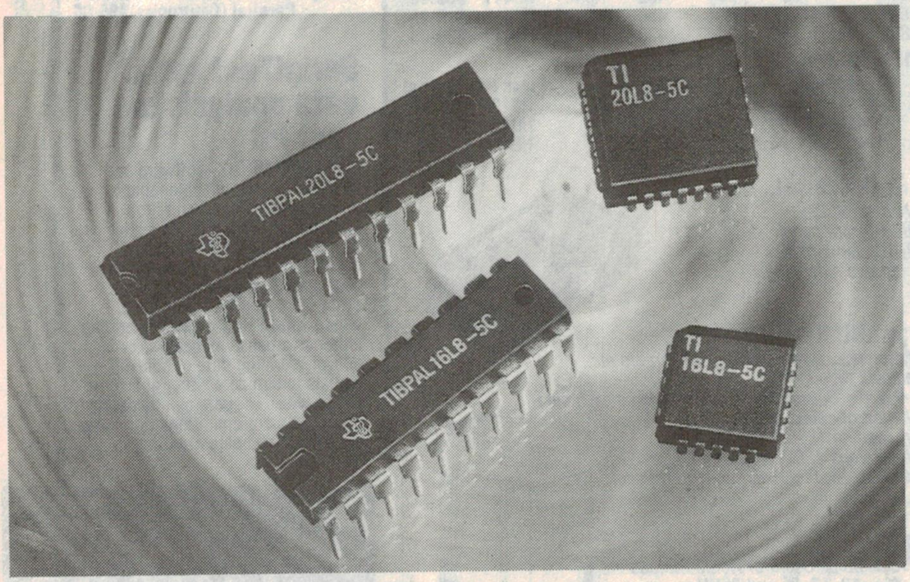


Five nanosecond PLDs

Texas Instruments claims to have released the first five-nanosecond TTL-compatible programmable logic devices (PLDs) to be available in production quantities. The industry-standard 20 and 24-pin PAL functions are drop-in replacements for previous generation 7ns versions, while offering a 21% improvement in noise characteristics.

Designed in TI's IMPACT-X advanced bipolar process, the new devices incorporate a variety of innovative circuit techniques that allows the use of standard packaging with corner power and ground pins.

TI says this shows that the key to controlling ground bounce and crosstalk noise in fast-switching bipolar devices is not in the packaging, but in the circuit design.

The newly-released devices are the TIBPAL16L8 20-pin PLDs, and the TIBPAL20L8 24-pin PLDs. Six more devices in the '16XX and '20XX series are planned for later this year.

Unlike conventional bipolar processes that use an oxide to isolate transistors on a chip, IMPACT-X uses a polysilicon-filled trench. This trench isolation, along with one-micron epitaxial layers and shallow base and emitter junctions, allows IMPACT-X to increase performance, triple packing density, and reduce power dissipation as compared to other bipolar processes.

TI's new 20 and 24-pin PLDs provide 5ns maximum propagation delays, 125MHz minimum cycle times (115MHz minimum with external feedback), and 4ns maximum.

For further information contact your nearest Texas Instruments office or phone (02) 887 1122.

14-bit multiplying DAC

Maxim Integrated Products has introduced a 14-bit CMOS multiplying digital-to-analog converter that offers higher precision, lower leakage current and is competitively priced with existing 12-bit DAC's.

Output leakage current of less than +10nA minimises offset errors in applications operating at high temperatures.

The MX7538 has a 14-bit wide data bus that easily interfaces with 16-bit microprocessors. A 16-bit uP can load data into the MX7538 in one instruction and the double-buffered inputs allow simultaneous updating of multiple MX7538's. The inputs can also be disabled, for applications requiring immediate updating of the output.

Applications for the MX7538 include automatic test equipment, digital audio synthesis, calibration circuitry and digitally controlled filters.

For further information contact Veltek, 22 Harker Street, Burwood 3125 or phone (03) 808 7511.

Frequency synthesis up to 500MHz

Plessey's SP2002 is a direct frequency synthesiser with square and selectable sine or triangle output waveforms, available from on-chip 8-bit digital to analog converters.

The chip output frequency can be programmed over the range 1Hz to 500MHz in 1Hz steps, the frequency being selected by means of a 30-bit externally applied binary word. The input clock frequency can be up to 2.14GHz.

Two 8-bit DACs are included, to produce both in phase and quadrature outputs switchable between sine and triangle waveforms. The in-phase and quadrature square wave outputs are continuously available.

For further information contact Plessey Semiconductors, Christina Road, Villawood 2163 or phone (02) 72 0133.

Voltage variable phase shifter

Merrimac's 0° to –360°, 10% bandwidth, voltage variable phase shifters are available within the 10 to 400MHz frequency range.

The voltage variable design is extremely useful in systems requiring automatic phase control, closed loop feedback networks and steering of electronically scanned antennas.

The PEP-4S series offers standard applications in three popular IF centre frequency ranges (30, 60 and 70MHz), with other frequencies available to custom order. The phase shifters are designed for high reliability, and can be supplied screened to meet specific military and space requirements.

For further information contact your local George Brown Group sales office or phone (03) 329 7853.

Silicon bilateral switch device

The Teccor Electronics Sidac 'K' series is a silicon bilateral voltage-triggered switch with greater power handling capabilities than standard diacs. Upon application of a voltage exceeding the Sidac breakover voltage point, the Sidac switches on through a negative resistance region to a low on-state voltage.

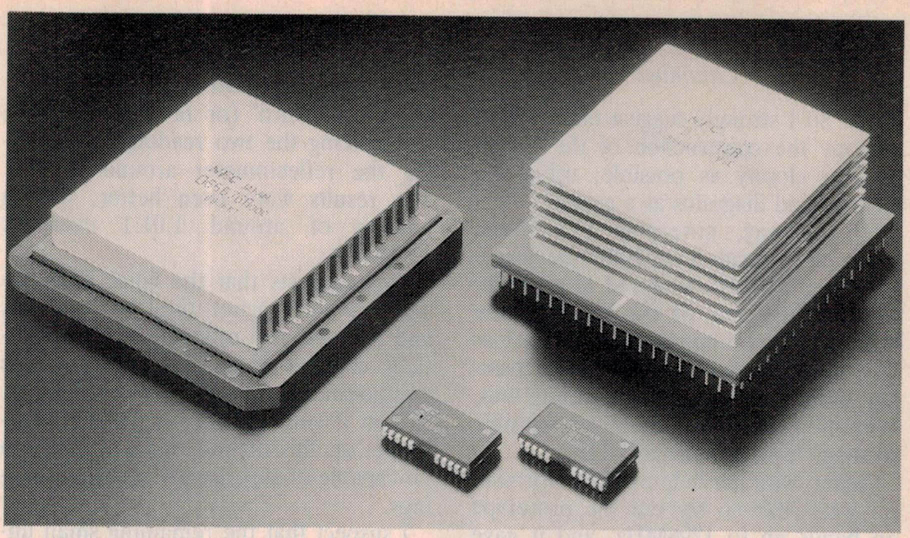
Conduction will continue until the current is interrupted, or drops below the minimum holding current of the device.

Low voltage Sidacs (95-170 volts) are available in either the To-92 package – or the SMD SOT-89 package. High voltage Sidacs (190-330 volts) are availabe in the TO-202AB package for greater power handling capability.

The 'K' series feature glass passivated junctions, to ensure a rugged and dependable device capable of withstanding harsh environments.

Typical applications for the devices are HV lamp ignitions, natural gas ignitors, gas/oil ignitors, HV power supplies, over-voltage protection, pulse generators and fluorescent lighting ignitors.

For further information contact IRH Components, 32 Parramatta Road, Lidcombe 2141 or phone (02) 648 5455.



Channelless gate array

Gate arrays have been increasingly employed in a variety of electronic systems such as personal computers and office automation equipment.

In response to demands for gate arrays which can operate at high speeds, are large in scale, and can be compounded by integrating RAM and ROM, NEC has developed a new family of gate arrays. The new family, CMOS-6, integrates a maximum of 177K gates.

The CMOS-6 gate arrays are innovative. Their transistors (cells) are laid out on the core areas of an LSI chip in advance and route areas are not fixed. Rather, the transistors are used as either functional blocks or routing areas as necessary. This type of gate array is sometimes referred to as 'channel free' or 'sea of gates' type.

The CMOS-6 family gate arrays can operate at ultra high speeds. Power gates with a high load driving capability, keeping the same speed with conventional BiCMOS gate arrays, are available.

For further information contact NEC Australia, 11 Queens Road, Melbourne 3004 or phone (03) 867 6355.

Quad differential bus transceiver

National Semiconductor has introduced the RS-485 quad differential bus transceiver for high-speed, multipoint bus applications. The DS36950 is a low-power, space-saving transceiver that features half the power consumption and space of its predecessor, the single DS3695.

The DS36950 is used in IPI (intelligent peripheral interface) and proprietary parallel busses to interface peripheral devices with computers and workstations. Six DS36950's can be used to implement a complete system. Previously, 24 DS3695's were required.

The DS36950 is available in a compact, 20-pin surface-mount package, using 60% less board space than single transceivers in DIP packages and 20% less than SOIC packages.

It typically consumes only 20mA of power per transceiver in quiescent mode, 50% less than earlier devices, and also features a typical driver propagation delay time of 13ns – with sydney data transfer rates as high as 10 megatransfers per second.

For further information contact National Semiconductor Australia, 3 Thomas Holt Drive, North Ryde 2113 or phone (02) 887 4355.

Single chip 2400bps full duplex modem

The Rockwell RC2324DP/1 is a single chip CMOS 2400bps full duplex modem data pump device. It meets the requirements specified in CCITT V.22bis, V.22A/B, V.23 and V.21, as well as Bell 212A and Bell 103. It also operates over the public switched telephone network (PSTN) as well as on point-to-point leased lines.

In addition, SDLC/HDLC support eliminates the cost of an external serial input/output (SIO) device in products incorporating error correction protocols.

The modem includes two CMOS VLSI functions – a digital signal processor (DSP) and an integrated analog (IA). The RC2324DP/1 integrates these functions into a single device.

The RC2324DP/1 is available in a 68/-pin plastic leaded chip carrier (PLCC), and with the addition of a few external filter components, interfaces easily to a data access arrangement (DAA).

For further information contact VSI Electronics, 16 Dickson Avenue, Artarmon 2064 or phone (02) 439 8622.

Parallel input tone pulse dialler

The UM91531 provides a 4-bit data input and a handshaking signal to serve as microcomputer interfaces. Under microcomputer control the UM91531 generates both a DTMF signal and a pulse output for telephone dialling.

All necessary dual-tone frequencies and dial pulse outputs are derived from a widely used TV crystal standard, providing high accuracy and stability. The required sinusoidal waveform for individual tones is digitally synthesised on the chip, resulting in a waveform with very low total harmonic distortion.

For further information contact Zitech Electronics at 57 St.Hellier Street, Heidelberg Heights 3081 or phone (03) 459 7222.

VHF Powermatch

Continued from page 129

UHF. So I strongly suggest that you try to copy the construction of the prototype as closely as possible, using the pictures and diagrams as a guide.

By the way, note that F29 ferrite beads are threaded on both the active wires and shields connected to each detector, at the end of the board. These beads are *very* important – they act as RF 'chokes', preventing RF from passing down the leads to the metering unit. Without them, you cannot get sensible readings from the unit at UHF.

Again, with the help of Dick Norman, we were able to try out the prototype on bands up to 1296MHz, and it gave very gratifying results indeed. With the high-quality dummy load mentioned previously, we were able to read less than 1.02:1 at 144MHz and 432MHz, and better than 1.1:1 even at 1296MHz, using both detectors and lines. This is surely a tribute to the terminations provided by the chip resistors, the 'taming' effect of the ferrite beads and the balanced PCB layout achieved using Protel's *Autotrax*.

Just for the record, we also tried using a single coupling line alone to make both 'forward/calibrate' and 'reverse/SWR' measurements – by simply leaving the metering unit switched to the 'Forward' (or reverse) position, and making the two readings by swinging the reflectometer around instead. The results were even better, with a reading of around 1.01:1 even at 1296MHz.

This suggests that the basic PCB design and construction used has paid off, and that the new reflectometer is essentially capable of making quite realistic measurements up to at least 1296MHz. In fact if you use the 'single line' technique, on this highest band, it looks to be capable of surprisingly accurate readings.

I suspect that the remaining small unbalance evident at 1296MHz using the normal 'both lines' technique is due to parameter spreads in the Schottky diodes. If this is the case, it may well be possible to achieve full accuracy with both lines at 1296MHz, by selecting diodes until you find a pair that are well matched.

The way to do this is to build up the unit as shown, and check it with a known dummy load at 1296MHz using both the 'single line' and 'both lines' techniques. You'll almost certainly find that the single line method will give the lower SWR reading, due to imperfect diode matching. Then it will be a matter of trying other diodes, until you get a pair which produce as low a reading with both lines as you get with a single line.

This will be fiddly, and also not cheap – as noted before, Schottky diodes are currently around $2.50 each, and you'll have to cut their leads and solder them into place to try them out. But if you can find a pair that are reasonably well matched, you'll end up with a 'home-brew' UHF reflectometer that will be comparable with commercial units costing at least $1000.

Coming soon

Well, that's all for the present batch of VHF Powermatch accessories, but I hope there will be a couple more to join them soon.

Currently I'm trying out a new RF impedance bridge design, and it's looking quite promising. I'm also hoping to come up with a decent VHF/UHF dummy load (finally!), and perhaps a matching attenuator pad for the power detector.

So stay tuned for further developments.

Monitor Alarm

Continued from page 131

and forcing the reset input of IC3 low. IC3 is thus prevented from oscillating and its output remains low. When the infrared beam is interrupted, IC2 turns Q1 off, allowing the reset input of IC3 to go high, and its output to oscillate at 870Hz.

The 870Hz tone signal is applied to the base of transistor Q2 via a series 2.2M resistor and capacitor. Q2 and its associated components form a very low power FM transmitter. L1 and VC1 form a tuned collector load for Q2, while the 3.3pF feedback capacitor ensures oscillation. Therefore, when the 870Hz tone is present, it modulates the transmitter at that frequency.

VC1 is included to allow the transmitter to be set to a convenient position in the FM band, with output to the antenna taken from a tap on L1.

The construction of L1 isn't critical; 8 turns of 0.5mm diameter copper wire wound on a 4mm diameter drill bit should suffice.

The antenna, connected to L1 of the third turn from the supply end, should be about 1.5 metres long for a maximum FM range of about 25 metres.

Construction

I have included full size PCB patterns which I used for my prototype, as well as the corresponding component overlays and parts list. The following comments and suggestions concerning construction of the unit should also be of interest to those wishing to build one.

Since there are two parts to this project (the infrared transmitter and the infrared receiver/FM transmitter) two separate enclosures are required. Also in most applications of the project (as in mine), the enclosures must be weatherproof. Therefore, I suggest that diecast aluminium boxes be used – 100 x 25 x 50mm (DSE Cat.No. H2221 or similar) for the IR transmitter, and the 120 x 40 x 65mm size (DSE Cat.No. 2211) for the IR receiver/FM transmitter PCB.

If the unit is to be powered from a battery, a 12V/1.2Ah 'gel cell' would be ideal for outdoor operation. If a larger enclosure is available, the IR receiver/FM transmitter PCB and the battery may be put in one enclosure, and power run to the IR transmitter via an underground cable suitably protected.

Finally, note that inductor L1 in the circuit diagram is now part of the copper pattern on the PCB, simplifying construction.

Australia's new seagoing research laboratory:

A tour of the 'Aurora Australis'

by TOM MOFFAT

A seasoned veteran of marine journeys to the Antarctic, Tom Moffat has fond memories of freezing days spent in the crow's nest of the old *Nella Dan* on iceberg watch. But a few weeks ago he had the opportunity to look over Australia's spanking new Antarctic research vessel when it was berthed in Hobart. As he found, it's loaded to the gunwales with the latest electronics.

Aurora Australis is the latest flagship of Australia's Antarctic Division, replacing a long line of mostly Danish ships plying the southern waters. She is the first Australian-built ship to enter the Antarctic service, built in Newcastle at a cost of $124 million. The ship belongs to the P&O Polar organization, and will be leased to the Antarctic Division for the next 10 seasons.

Aurora Australis is really two ships in one – a cargo ship, to carry supplies and personnel to and from Australia's Antarctic stations, and a research vessel. She takes the place of the *Nella Dan*, the faithful Danish ship that served Australia for many years before running aground at Macquarie Island. *Nella Dan* was subsequently scuttled, amidst circumstances that are still controversial to this day.

Aurora is much bigger than the *Nella Dan*, and has full ice-breaking capabilities which should allow her to charge ahead in ice conditions that sometimes left *Nella* beset for weeks at a time. *Aurora's* size is such that when you are walking around on her while she's tied up at the wharf, you tend to forget you're on a ship. In many ways it's more like touring a university research institute, or the labs at the Antarctic Division headquarters in Hobart.

As well as resupplying the stations, *Aurora Australis* conducts oceanographic research all the time she's underway. There are five shipboard research labs and space on deck to install a couple of others in sea containers for special-purpose cruises. The ship also bristles with sensors for collecting data on such things as depth, water temperature and salinity – anything to do with the ocean environment. The labs and the sensors are all connected back to a central computer room on the ship via an Ethernet networking system. As she moves along, *Aurora* is like a giant data vacuum cleaner, sucking in anything of interest and storing it for later detailed study.

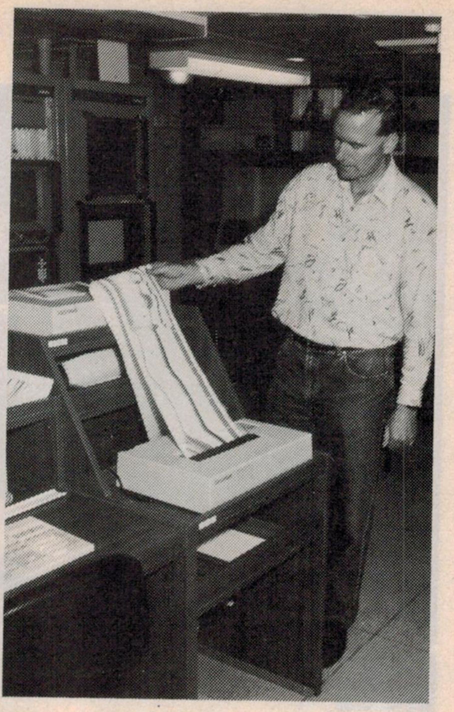
The computer room on *Aurora Australis* shares space with a large rack of equipment for acoustic study of the ocean. 'Acoustic' means depth sounders, some of them very specialised. On the *Nella Dan*, depth sounder studies were done in a very direct and manual way. There was a large Norwegian-made depth sounder in the chartroom behind the bridge, and near it a satellite navigation system. The sounder was strictly mechanical; a slowly moving roll of paper, and a scanning stylus that went scratch-scratch-scratch across the paper, burning a depth profile into it with an electric current.

Depth studies went on 24 hours a day. Every five minutes whoever was 'depth sounder attendant' had to read the satnav and record the ship's position, course, and speed in a book. Next you had to read the present depth from the sounder and record that as well. Finally you had to open the door of the sounder and write the time on the moving paper, trying all the time to jump out of the way of the whizzing stylus. If it got you, it would deliver a nasty electric shock.

Everyone aboard the *Nella Dan* was rostered on depth sounder duty an hour at a time. This included journalists like me who were not part of the scientific party, and my own stints always seemed to be from 3am to 4am or something equally attractive. Your last job before going back to bed was to wake your replacement – not always a pleasant task.

This same kind of activity takes place aboard the *Aurora Australis*, although now it's all automatic. There is not one, but several depth sounders, including the latest Simrad EK400 scientific depth sounder which has only been on the market for a few months. There's no moving paper and stylus with this instrument; they've been replaced by a colour computer screen.

The Simrad actually contains two individual sounders, one running at 38kHz with 5000 watts of peak power, and the other on 200kHz with 500W. There are also two other sounders running on 120kHz, one with a split beam which allows it to show position information of a target as well as its depth.



ANARE computer programmer Howard Burton checking the output from the HP colour inkjet printer, which gives hard copy of the depth sounder images.

Instead of requiring members of the ship's company to record readings in a book day and night, *Aurora's* acoustic equipment sends its data to a Hewlett Packard computer system which records it automatically. The system can run completely unattended if need be.

Sea bottom profiles are recorded continuously as on the *Nella Dan*, but now scientists are after something more elu-

The ship's nerve centre and central gathering point for all data: its VAX computer.

A Tour of the Aurora Australis

A closeup of the master console on the bridge. The small TV monitor shows a view from the top of the mast, where a remotely controlled camera replaces the traditional 'crows nest'.

sive: krill. These are tiny shrimp-like creatures that are the foundation of the whole food chain in the Antarctic. Krill feed seals, whales, birds, all kinds of Antarctic life – and it's intended they may even feed people one day. Krill are one of the world's most bountiful sources of protein.

Scientists would like to know if the krill population is increasing or decreasing, how and why it moves, what attracts or repels it, where it comes from and where it's going. The elaborate depth sounder installation should let scientists see swarms of krill and work out where they are, how deep they are, and how big they are. Trouble is, krill are so tiny that the depth sounder echoes they return are just above the system noise level.

Scientists hope that the different depth sounder frequencies will produce different images or 'signatures' of krill. By taking into account the signatures produced by all of the depth sounders running simultaneously, it should be possible to say for sure, "Hey, there's a swarm of krill, X metres by Y metres across, and Z metres deep". If it is then necessary to study these krill more closely, it's a simple matter to chuck a net over the stern and haul a few in.

Krill snared by nets, as well as fish, end up in one of the *Aurora's* 'wet labs'. These areas have smooth surfaces from floor to ceiling, and are designed to withstand a tremendous onslaught of fish innards. Since everything is smooth and watertight, cleaning up afterwards is just a matter of hosing it down. The wet labs contain clean enclosed areas where computer terminals can be used to record data from fish and krill studies.

There are a couple more labs which are in reality giant freezer rooms, where temperatures can be brought right down to Antarctic levels. The obvious question is, if the ship is in the Antarctic, why don't they just open the windows?

The answer is that the labs can be kept Antarctic-cold even when the ship is back in Australia. Sometimes it is necessary to bring samples back alive, and many creatures would die if removed from their Antarctic environment.

Another interesting device is the 'CTD' unit, standing for conductivity, temperature, and depth. This instrument can be lowered on a cable to depths of 6.5km or more, from where it can send back measurements of its environment. There is also a little submersible camera device which can send back pictures from great depths.

Back on the surface, salinity and temperature are also measured, as well as the concentration of chlorophyll in the water. Chlorophyll measurement is continuous – there is a pipe connecting an inlet outside the ship back to a 'fluorometer' in one of the labs. As water runs through this device, the chlorophyll level is measured and recorded on a personal computer. Readings are then transferred back to the computer room via a serial link.

The computer room, then, is the 'brains' of the outfit, with tentacles reaching out to every scientific area of the ship. It also receives information about the ship's position, course, and speed, as well as weather data. Every-

The 'acoustic' instrument rack, with the various depth sounders on the right, and the Hewlett-Packard computer on left.

thing is compared with everything else, and then 'gelled' into a master picture of the ship's environment at a given moment. The significance of all the data is worked out in a big Digital Equipment VAX computer system which occupies the centre of the computer room.

Once the information is digested, the computer will have a continuous record of data such as "we found krill at latitude such and such, longitude so and so, while we were going this fast in that direction. The swarm was X by Y metres in size and was Z metres deep. Lab analysis showed the krill to be of whatever type. This all happened at something-or-other time on this-or-that date, while it was cold outside and snowing. At the depth we found the krill, the water temperature was something and the salinity was something else."

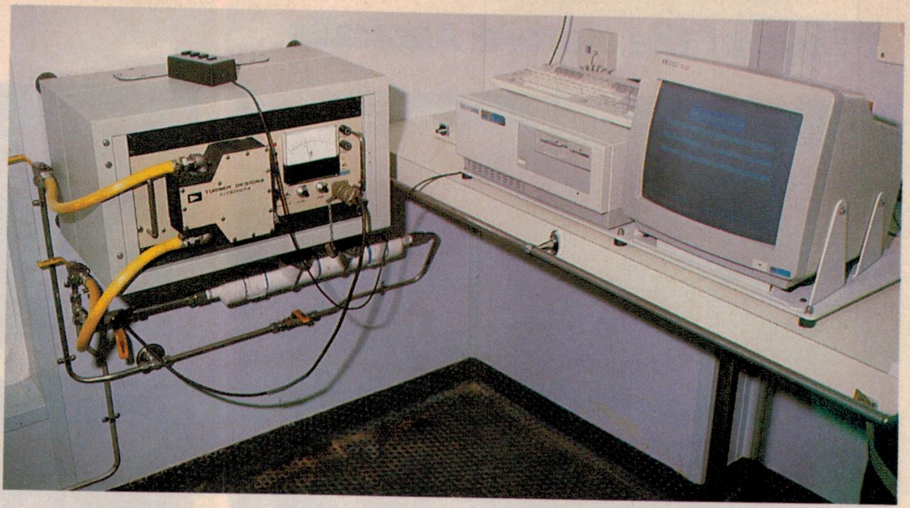
You get the idea. The data don't refer only to krill, of course; more general oceanographic information is also being recorded, to take its place in the storehouse of everything that's known about the world's oceans. Of particular interest to Antarctic scientists is a study of how melt water comes off Antarctica's ice shelves.

So much for the floating research institute, how about the ship itself? *Aurora Australis* is an example of the very latest in electronic control. On the *Nella Dan's* bridge there was the traditional ship's steering wheel where the helmsman could stand while looking very brave and important. Passengers liked to be photographed at the wheel as well. There was also the classic engine-room telegraph, with positions for 'full-ahead', etc., and a couple of big old circular radar displays with black rubber hoods.

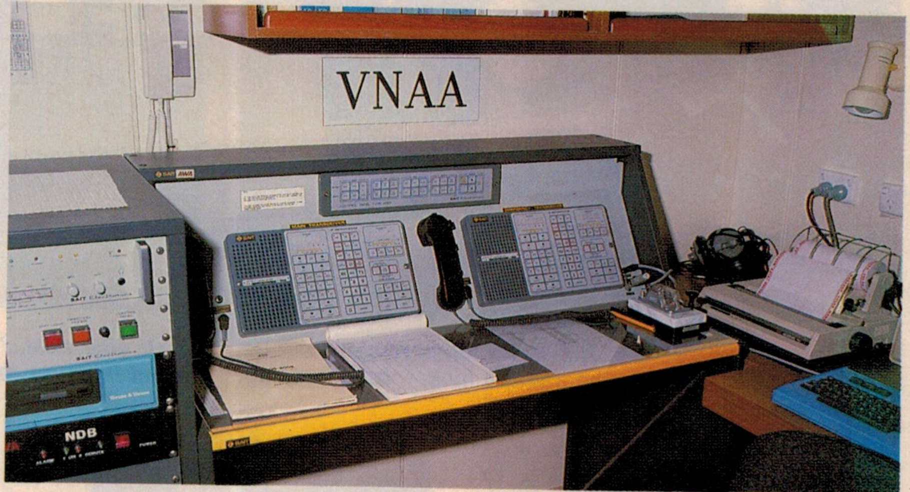
The only real concession to modern technology was a little hand-held control unit at the end of a long cord. This had a knob that could be used to control the ship's rudder while the helmsman was peeking over the side to watch the ice, or during docking maneuvres.

Forward of the bridge, outside, was an old-fashioned 'crow's nest' where a lookout could be placed to find a way through the pack ice. There was also a control unit in the crow's nest, so the ship could be steered from there if necessary. The crow's nest was another interesting hang-out for passengers.

In comparison the bridge on *Aurora Australis* is truly gigantic, but mostly empty. In the centre is an enormous console, flanked by a couple of space-shuttle seats. They look like you could have your teeth fixed in them, if you

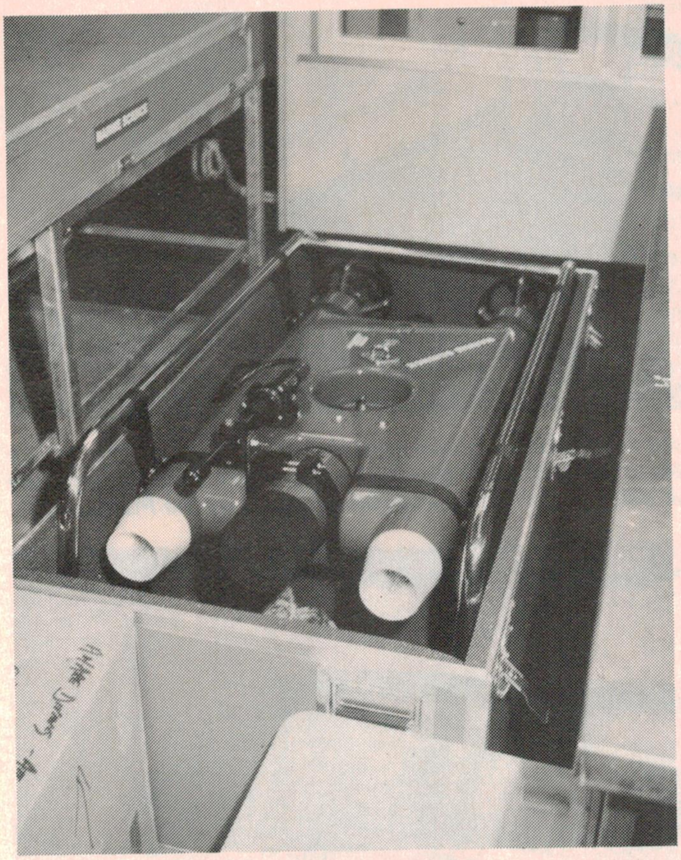


The fluorometer, used for continuous measurement of chlorophyll. The yellow pipes carry seawater from a sampling hole in the ship's hull through the instrument and back out again. Data is processed initially by the PC at right.



The hot seat in the radio room. Not a tuning knob in sight – or any other kind of knob, for that matter!

The navigation desk. Just look at all of those satnavs...



The submersible camera. The white tubes enclose strobe lights, above and below the camera lens – here wearing a dark lens cap.

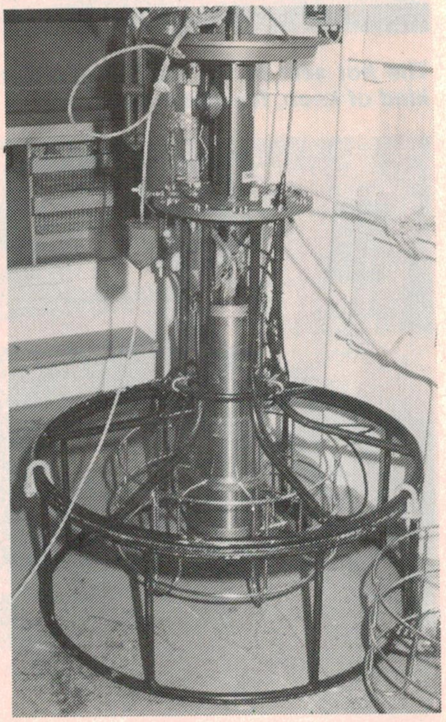
'If all else fails...' Aurora still carries a set of traditional signal flags, as mentioned in the text.

leaned them back. There is a big TV-style radar screen in front of each seat, and to one side – a tiny joystick, like on a computer game. A couple of gentle fingers on the joystick can make the ship go forward, aft, port or starboard.

In the middle of it all is a small 'wheel' that looks like it would be more at home on an aircraft. This is said to be for traditionalists – like marine pilots – who don't want to face the joystick.

There is no crow's nest on *Aurora Australis*; instead, a video camera is mounted on top of the mast. The camera has remote pan, tilt, and zoom controls, and connects to a small TV monitor in the centre of the main console. The camera is used to find a way through pack ice, avoiding the need to send someone aloft to spend the day freezing in the crow's nest.

In the radio room – no knobs! Not one. All the radio gear is controlled by keypads. There is one concession to tradition, a morse key – one of those really flashy ones with a marble base. The radio operator said it was unlikely



The CTD (conductivity-temperature-depth) sensing device.

it would ever be used. This is in contrast to the *Nella Dan* of a few years ago when most official ship's traffic was passed by Morse Code, all the way back to Denmark.

And if all else fails, back on the bridge, *Aurora Australis* carries a supply of brand new signal flags. Does anyone still know how to read them?

Will *Aurora Australis* ever really replace the *Nella Dan*? In scientific terms, and in practical terms, *Aurora* is streets ahead. She'll go places and make discoveries that *Nella Dan* never dreamed of. But emotionally, *Aurora's* got a hard act to follow.

Nella Dan had class; she was a true lady of the sea. She was a happy home and a magic carpet to many expeditioners who leaned over her rails to ogle their first icebergs, or to do less pleasant things as the ship rolled over by 40 degrees. Many a tear was shed when *Nella* met her end, and memories of the ship still bring a lump to the throats of expeditioners. Let's hope that *Aurora Australis* can develop such a devoted following.

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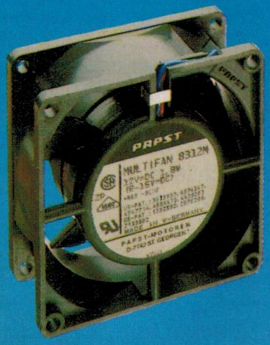

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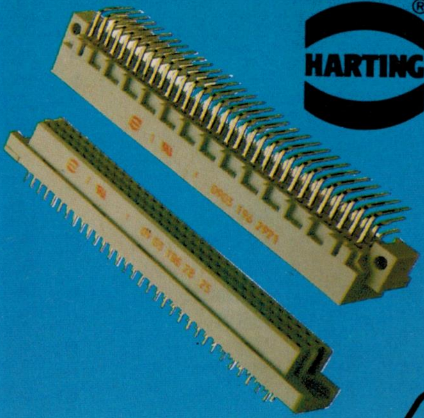

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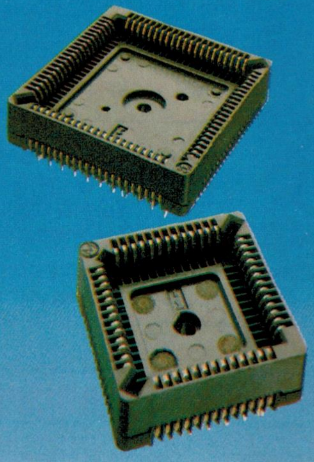

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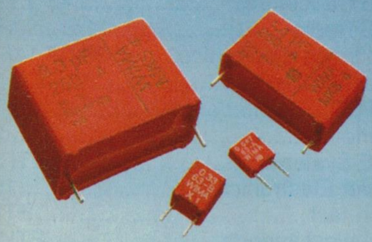

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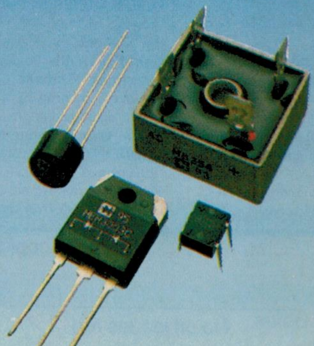

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